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**BELMONT MANSION, A CONDITIONS SURVEY
OF THE ORNAMENTAL PLASTER CEILINGS OF
ROOMS 101 AND 205**

Amy Cole Ives

A THESIS

in

Historic Preservation

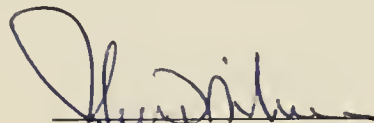
**Presented to the Faculties of the University of Pennsylvania in
Partial Fulfillment of the Requirements for the Degree of
MASTER OF SCIENCE**

1996



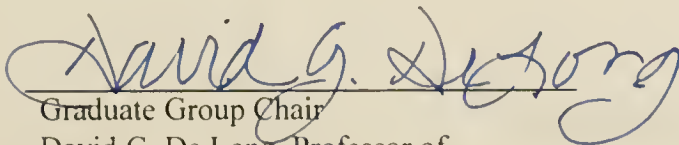
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FORWARD

I would like to thank my husband, Jonathan, first of all for his tremendous energy and support this past year. His enthusiasm and interest in my work helped to make this project a lot of fun. Many thanks go to my advisor, Frank Matero, and my reader, John Milner, for all their help and shared experience. I would also like to thank the following people who have been so generous with their time, Rollin Lakis from the Laboratory for Research on the Structure of Matter at the University of Pennsylvania, Suzanna Barucco and Peter Copp from Martin Jay Rosenblum, R.A. and Associates, Maribel Beas, Cassie Myers, Dr. Gomaa Omar from the Geology Department, and my classmates Evan Kopelson and Rynta Fourie.

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1. INTRODUCTION

Architectural conservation, like the study of medicine, is a diagnostic science. Intervention is based on diagnosis of the problem, and diagnosis on identification of the cause and nature of the problem. Identification of the problem is accomplished through a study of the documented symptoms and their context, and of course, this identification can only be as complete and exact as the documentation of those symptoms. Notwithstanding any of the above variables, the success or value of each of these steps is always contingent upon asking the appropriate questions. Thus the importance of the conditions survey, as the first step towards diagnosis and treatment, cannot be undervalued. It is at this base level that a fundamental understanding of the materials and the system of which they are a part is gained, an understanding that is necessary to avoid treatments or interventions that could cause irreversible damage to the historic fabric attempting to be conserved. The value of having a thorough record of that historic fabric for future study, and as a reference to establish the rate of change over time, should also not be underestimated.

In 1987-88, two studies were undertaken to examine the architectural and historic significance of ten historic Fairmount Park houses and to look at the adaptive use potential of these ten sites.¹ Based on this survey, Belmont Mansion was identified as having substantial historical significance and adaptive use potential (Figure 1). Martin Jay Rosenblum and Associates completed an extensive Historic Structures Report (HSR) for Belmont in January 1992. The HSR substantiated the importance of Belmont and the eighteenth century ornamental plaster ceiling in the hall, and made recommendations for

¹Fairmount Park Historic Houses Study, Prepared for: Stockton, Rush, Bartol Foundation, The William Penn Foundation, The Pew Charitable Trusts and the Fairmount Park Commission. Prepared by: Council for Historic Sites and Kieran Timberlake and Harris, October, 1987 report, and Philadelphia Historic Preservation Corporation, Urban Partners, Jackson and Kihn, and John Milner Associates, June, 1988 report.

the restoration of the mansion and adjacent buildings and specifically for the conservation of the plasterwork (Figure 2). In 1995, staging was erected to secure the plaster ceilings in the hall and stairtower for the planned restoration work on the building.

The aim of this study of the ornamental plaster ceilings at Belmont Mansion is threefold: to record the amount, degree and type of failure present in the ceilings, to identify the possible causes of deterioration and to establish a base record of the conditions with which future monitoring and documentation can be compared. Due to time constraints and the complexity of the existing conditions of the plaster ceiling in room 101, that ceiling has been the primary focus in this study. The amount, degree and type of failure has been recorded for both ceilings, but the evaluation and diagnosis of the mechanisms of deterioration has only been pursued for the ceiling in room 101.

Critical to any conservation effort is understanding the significance of the subject and the technology of its construction. The fact that there are so few eighteenth century American ornamental plaster ceilings and that there has never been an inventory or collective study of those extant, makes it difficult to place Belmont's ceilings in a context or to understand their significance. The study of ornamental plaster ceilings in Great Britain, the tradition out of which the early Anglo-American ceilings came, has been established for some time, although literature on the conservation of plasterwork has been produced only more recently. With a history of ornamental plastering that dates back to the 16th century, the impressive inventory of ceilings that has come out of that tradition, and the large number that still survive, it is not surprising that the bulk of the literature published in English on ornamental ceilings has come primarily from British and Scottish sources. The repair and restoration of ornamental plaster ceilings in the U.K. is still a common enough phenomenon that it is included in maintenance manuals such as Melville and Gordon's *The Repair and Maintenance of Houses* published in 1988.

William Millar's *Plastering Plain and Decorative* from 1897, is a monumental work that covers everything from the historical development of plasterwork technology

and stylistic trends, to detailed instructions on casting column capitals. The literature that followed Millar's work was focused primarily on the study of the artistic development of ornamental ceilings. Bankart's 1909 *The Art of the Plasterer*, Jourdain's 1926 *English Decorative Plasterwork of the Renaissance*, and Turner's 1927 *Decorative Plasterwork in Great Britain*, together form a photographic inventory of ornamental plaster ceilings that documents the rich heritage of plasterwork in the U.K. and helps to shape the context from which many early ceilings in America came from. Geoffrey Beard's 1975 *Decorative Plasterwork in Great Britain* also looks at the artistic development of the craft, but he takes a more genealogical approach to the study by pursuing the builders and plasterers of the ceilings in his research, and in doing so adds another dimension to the inventory of plasterwork in Great Britain.

One of the earliest works on the preservation of plasterwork is J.F.S. Jack's 1950 "Notes on the Repair and Preservation of Decorated Plaster Ceilings" published in the *Royal Institute of British Architects Journal*. In this article Jack covers examination of plasterwork from below and above, temporary support and stabilization, and reattachment of plaster to its support. The methods that Jack outlines are essentially the same ones found in Historic Scotland's 1994 Technical Advice Note 2, *Conservation of Plasterwork*. The development of new methods of plaster conservation in the United States has been led since 1976 by Morgan Phillips using water-soluble acrylic resins for consolidation of plaster and acrylic adhesives for the reattachment of plaster to itself and its support.

1870-1871

1871-1872

1872-1873

1873-1874

1874-1875

1875-1876

1876-1877

1877-1878

1878-1879

1879-1880

1880-1881

1881-1882

Figure 1 Belmont Mansion, October 1995.



Figure 2 Room 101 ornamental plaster ceiling, east side.

From Martin Jay Rosenblum, R.A. and Associates, 1990.



2. METHODOLOGY

The primary objective of this study is the documentation of the two ornamental plaster ceilings of Belmont Mansion. The main components of the documentation process in architectural conservation are documentary research and physical investigation. The documentary research for this study establishes the historical background, stylistic context and construction technology of the subject, while the physical investigation identifies the composition of the plasters and finishes, establishes a record of the current condition of the plasterwork and documents evidence of past conditions and interventions. The 1992 Historic Structures Report completed an exhaustive investigation of the Peters family, so additional research of the historical background of Belmont was not necessary. The documentary research undertaken for this study focused instead on the stylistic context and construction technology of the ceiling plasterwork. Contemporary architectural treatises and builders' pattern books were consulted to help establish the stylistic and technological context, in addition to published photographic collections of British ceilings and published examples of early American ceilings. Contemporaneous builders' books were also consulted to learn more about eighteenth century plaster technology. Understanding the eighteenth century technology of the ceilings is an essential part of selecting or designing compatible conservation treatments or structural interventions. It is also important for the total appreciation of the historical significance of this particular plasterwork, as there are so few equivalent contemporaneous examples in the United States.

The physical investigation portion of the study was comprised of materials characterization and analysis of the stratigraphy and composition of plasters and finishes, and on-site recordation of existing conditions as well as investigation of past conditions and interventions. Standard methods of wet chemistry and microscopical analysis, including normal reflected and UV fluorescence microscopy and scanning electron

microscopy were employed to characterize the materials. Identifying the elemental composition of the plasters and the media of the paints is essential for the development or selection of future conservation treatments for the two ceilings. A preliminary investigation of conservation treatment options has been undertaken through a conservation literature survey of paint removal, plaster consolidation and reattachment techniques.

The existing conditions of the plaster surface were systematically recorded in a conditions survey that utilized the same methodology, definitions and graphic notation as the Drayton Hall Ornamental Plaster Ceiling Conditions Survey undertaken by the Architectural Conservation Laboratory of the University of Pennsylvania in 1990. The same conditions survey recordation techniques were employed for this project in an effort to continue to move toward establishing a standard format for conditions surveys of plasterwork in the field of architectural conservation.

The purpose of the conditions survey is to record the type, extent and degree of deterioration present in the ceilings to help determine possible mechanisms of deterioration. The conditions were graphically recorded on HABS plan drawings of the ceilings prepared in 1992 for the HSR, and will serve the additional purpose of establishing a base document of the conditions with which future monitoring can be compared. In analyzing the collected information from the materials characterization and conditions surveys to determine possible mechanisms of deterioration, it is important to understand that the problems exhibited in decorative plaster ceilings are no less complex than the structural problems of the building. For this reason the condition of the lath and plaster key support system, and the relevant framing members were also recorded as part of the conditions survey to establish the framing, plaster support and decorative plaster relationship.² The specific questions this deterioration diagnosis has raised are: Is the

²These two surveys were only carried out for the room 101 ceiling, as the lath and plaster keys above the room 205 ceiling are currently completely obscured by debris.

distress visible in the ceiling (in the form of numerous large and small cracks) due to intrinsic factors, such as the integrity of the materials, design, installation and subsequent maintenance and repairs to the plasterwork, and/or is it due to extrinsic factors such as the structural condition of the building, interventions to the building's structure or environmental factors.

3. HISTORICAL BACKGROUND AND SIGNIFICANCE

3.1 WILLIAM PETERS TO FAIRMOUNT PARK

The following is a brief summary of the extensive historical narrative from the Historic Structures Report. It is meant to serve as an introduction to William Peters, the builder of Belmont Mansion, as well as a recap of the past two hundred years of owners and tenants and the changes that they brought with them.

William Peters was a wealthy lawyer from Liverpool, England who settled in Philadelphia in 1739.³ He was preceded to the colonies by his younger brother Richard Peters, an Anglican clergyman, who had established himself in Philadelphia in 1735 as Assistant Rector of Christ Church. In 1737 Thomas Penn, then Governor of Pennsylvania and residing in Philadelphia, appointed Richard Peters Proprietary Secretary of Pennsylvania.⁴ Richard's connections with the Penn family had a favorable impact on his brother's career in Philadelphia. Once established, William Peters continued his independent legal practice, performing much legal service for the Penn family. He also procured numerous lucrative public offices through the Proprietors, including: Notary Public for Philadelphia in 1742, Register and Scribe of the Admiralty Court of Pennsylvania in 1744, Prothonotary of the Superior Court in 1752 and Land Office Secretary in 1761.⁵

Even though Peters had left a family behind in England when he came to Pennsylvania in 1739, he had started another one in Philadelphia by 1742 when he had a

³Belmont HSR, 1-14. All historical background information for this report comes from the extensive Historic Structures Report completed by Martin Jay Rosenblum and Associates in January of 1992 for the Fairmount Park Commission. Mark Reinberger directed the effort, performed the documentary research, and wrote the Historical Narrative (pages 1-1 to 1-76).

⁴HSR 1-9.

⁵HSR 1-12.

child out of wedlock with Mary Breintnal, a member of a large prominent Quaker family.⁶ When he purchased the Belmont property on the west side of the Schuylkill River in 1742, it already had a free standing farm house. Peters upgraded the building for his pregnant mistress and at the same time began construction on the mansion and extensive gardens and landscaping that eventually stretched from the Schuylkill to an obelisk half a mile to the west of the house.⁷ A letter from Thomas Penn to Peters in 1743 referring to Belmont as "your Country Retirement," in addition to a date stone marked "W.P. 1745," and a visit recorded by Deborah Logan in 1819 when she was told the mansion was nearly 80 years old, all point to a construction date for Belmont in the first half of the 1740s.⁸ This construction date would make Belmont, with the exception of Penn's Springettsbury Manor, the earliest of the country villas located in Fairmount. The significance of this early date lies in the architectural quality of the building and its detailing, especially the modelled plaster ceiling in the hall.

A more personal understanding of Peters and his villa can be found in his surviving letters. His taste for good food is clear from his ordering beer and cheese from England, as well as his taste for gardening with his order of tulip bulbs. Peters also ordered a great number of books, mostly legal, purchased the *London Magazine and Appendix*, and was a member of the Library Company of Philadelphia.⁹ Music and the visual arts were additional interests that Peters followed. In a letter from 1742, Thomas Penn wrote to Peters:

⁶HSR 1-14.

⁷HSR 2-1.

⁸HSR 1-14.

⁹HSR 1-15. The HSR does not mention if any of the books Peters ordered were architectural pattern books or treatises, this would be an interesting topic to pursue further, as would be finding out what architectural books were available at the Library Company when he was a member.

I have desired my brother Richard to enquire for a violin for you and as he is acquainted with all the musical people of any note believe he will get me one that will play also upon a harpsichord.¹⁰

A letter dated May 1740 also records the importation of seventeen music books. This musical patronage takes on additional meaning as it references the modelled plaster ceiling in the hall which has groups of instruments on the north and south sides. William Peters was active within the visual arts both as a patron and a designer. Peters and his wife Mary had their portraits painted and there is record he accepted paintings from the artist Joseph Molineaux in Liverpool as rent payment.¹¹ Richard Hockley's comment in a letter to Thomas Penn from 1749 about a house he built in Society Hill confirms that Peters was able to draw and was familiar with architecture: "the plan as drawn by Mr. Wm Peters & one Harrison. . . Tis a very compleat one, of the dimensions, and the best I think by far in this place and most convenient and commodious."¹² His handwriting also appears on the earliest plans for Cliveden, Benjamin Chew's later country house. Peters knowledge of architecture was not limited to drawing and designing, his experience with building is illustrated by the fact that Penn entrusted him with the supervision of planning and construction of a ferry house on the Delaware.¹³ The stone for the cellars of this building came from Peters, probably the same quarry on the Belmont property from which his son Richard would later sell stone. It is also interesting to note that lime was

¹⁰HSR 1-15.

¹¹HSR 1-15.

¹²HSR 1-16.

¹³HSR 1-16. The HSR adds an adjunct to this story about the quarrel between Peters and the master carpenter for the project, Ebenezer Tomlinson. Apparently the quarrel predated the ferry house project and the HSR poses the question that maybe Tomlinson built Belmont or Peters's town house. This is the only time the question of the builder of Belmont is raised, an issue that with enough time would be worth pursuing. One possible lead has been uncovered by Jean Wolf at the State Archives in Harrisburg. It is the daybook of house carpenter William Alexander with entries from 1745 including: "22nd Feb . . . sd Wm Alexander hereby agrees and promises to do all such carpenters work for his sd Wm Peters at his house and buildings at his plantation this present year. . ."

being burnt on the Peters land at a very early date.¹⁴ Here is a reminder that in addition to the ornamental landscape at Belmont, it was still also a working estate, and though Peters referred to Belmont as a "country retirement" he also referred to it often as a "plantation".¹⁵

Following a number of indiscretions in which Peters used his position in the Land Office for personal gain, he was relieved of his office and retired to Belmont. After one season he left Belmont to travel, eventually going back to Liverpool, England. He never returned to Philadelphia, thus deserting his second family.¹⁶ William Peters's son, Richard Peters inherited Belmont, and after the close of the Revolutionary War passed part of every year there, moving there permanently by 1810.¹⁷ Richard Peters spent his life in public service, and as he was intimate with many of the leading members of the new Federal government, a number of the founding fathers visited Belmont in the 1790s.¹⁸ He died in 1828 and the management of Belmont fell to his son Richard Jr.¹⁹ The next forty years were a period of heavy commercialization of the property, first by Richard Jr., and then by the trustees of his will. Following Richard Jr.'s death in 1848, the mansion became a "boarding house" and it was probably at this time that the third floor was added.²⁰

¹⁴HSR 1-17. The HSR does not elaborate on this statement, but it is certainly worthy of clarification or even further investigation as it may be relevant to the construction of the plaster ceiling in the hall.

¹⁵HSR 1-26.

¹⁶HSR 1-30.

¹⁷HSR 1-49.

¹⁸HSR 1-48.

¹⁹HSR 1-67.

²⁰HSR 1-69.

In 1868 the Fairmount Park Commission, in an effort to secure the watershed to the Schuylkill River which was Philadelphia's water source, obtained title to the numerous mansion properties that lined both sides of the river. The commission decided to use Belmont as a restaurant and accordingly made a number of improvements to the property.²¹ The third floor and roof were rebuilt after a fire in 1905. During the twentieth century Belmont has been used on and off as a restaurant with interim periods of vacancy, with the last restaurant closing in 1980. After being abandoned for six years, the Junior League of Philadelphia selected Belmont as their 1986 Designer Showcase House. For that event some structural stabilization was undertaken and various rooms of the mansion were redecorated by different interior designers. The following year the house was leased to the American Woman's Heritage Society.²² Currently it is closed to the public for restoration and rehabilitation work by the Fairmount Park Commission. Martin Jay Rosenblum, R.A. and Associates is serving as project architect.

3.2 HISTORICAL CONTEXT AND CEILING DESCRIPTION

William Peter's Belmont dates from what is commonly called the early Georgian period (1700-1750) in American architecture (Figure 3). The early, middle and late Georgian periods, however, are not separate and distinct architectural styles but rather divisions in the span of time between George I becoming the English monarch in 1714 and the death of George IV in 1830. The predominant English architectural influence in the colonies during the first half of the eighteenth century is that of the English Baroque, which has been termed "Wren-Baroque" by architectural historian William Pierson.²³

²¹HSR 1-72.

²²HSR 1-75.

²³ William H. Pierson, Jr., *American Buildings and their Architects: The Colonial and Neoclassical Styles*, (New York: Oxford University Press, 1970) 69.

English Palladianism, initiated with the publication of *Vitruvius Britannicus* and an English translation of Palladio's *I quattro libri dell' architettura* in 1714, was a movement to reaffirm classical principals in architecture. "This style was the first phase of Georgian architecture and was totally different from that of Wren and his followers."²⁴ The ideology and designs of English Palladianism were introduced to the colonies through the same books which had sparked the movement, but also by way of other publications as well. James Gibbs's 1728 *A Book of Architecture*, and other pattern books by him were widely popular in the colonies. Gibbs's plates of domestic architecture illustrate plans for villas based on Palladian principles of the extended symmetrical plan, as well as plans for simple detached rectangular blocks, so characteristic of earlier Wren-Baroque buildings (Figure 4). However, most of his facade designs are more akin to the Baroque richness of Wren (with quoins, heavy rustication, pilasters and balustrades) than to the purity of rigid geometry and classical details of strict English Palladianism.

With few contemporaneous examples for comparison, it is possible to establish a basic architectural and historical context for Belmont Mansion by looking at the pattern books of James Gibbs and other publications from the period. The same situation applies to the ornamental plaster ceiling in room 101, where there are few examples of extant eighteenth century ornamental plaster ceilings to compare it with, and stylistically it is easier to establish its context by looking at pattern books. The ceiling is divided into two parts, the blank central field which is delineated by a heavy bolection molding and the ornamental elements organized around it in enframed panels (Figure 5). The corner panels are of two designs that are matched diagonally across the ceiling. Sprays of foliage with either ribbons or swags are accompanied by a large concave or convex scallop shell set between the corner panel and the central field. The center panels on the

²⁴ Pierson 112.

east and west sides of the ceiling are adorned with groups of musical instruments and floral swags with smaller stylized shells. The Peters family coat of arms is displayed half on the east and half on the west side of the ceiling along the axis of entry. Above the west door is a cartouche with two lions sitting back to back, and above the east door also set in a cartouche, is a shield with a diagonal bar and two small convex shells.

The organization and ornamentation of the ceiling in room 101 follows the recommendations of the writings of Isaac Ware and bears a strong resemblance to a design for a ceiling by Batty Langley (see below). In Isaac Ware's *Complete Body of Architecture* (1756), Book V, Part II, "Of Ceilings," Chapter XIII, Ware discusses how to design an ornamental plaster ceiling in the true taste with the distribution of the fields into large compartments with some depth to take advantage of light and shadow, versus designing a ceiling in a fanciful manner with French ornament. He writes in Chapter I "Of the ornaments of ceilings in general,":

The scope of fancy in the decoration of ceilings is very great, even without transgressing the severest rules of propriety: the division into compartments is natural and proper; and the first thing that offers to the imagination in the decorating, is the adding of mouldings in the divisions.

This we may call the first stage of ornament: the next in degree above an absolute plain ceiling. For the second degree we shall name the addition of sculpture to these mouldings; the centre of the compartment being all this time plain. A third degree, the centre still left plain, is the addition of scrolls and faces in the verge of circular designs.

The degree of decoration in these three kinds may differ, and thence may be given various stages of ornament, according to the expense: but this, in a general view, is all that can be done while the central part is left plain and vacant.²⁵

Figure 6 is a design for a ceiling from Batty Langley's *City and Country Builder's and Workman's Treasury of Designs* (1740, 1745).²⁶ The similarity between the composition

²⁵ Isaac Ware, *Complete Body of Architecture* (London: 1756), Book V, Part II, Chapter I, 485.

²⁶ According to the Park list, Peter Harrison is assumed to have owned the 1740 edition of Langley's *Treasury*, and members of the Carpenters Company of Philadelphia owned 1750 and 1756 editions.

of this plaster ceiling design, with a center field delineated by a bolection molding and acanthus leaf mitered corners, surrounded by enframed panels with floral swags and sprays of foliage and drapes, and the ceiling at Belmont is quite striking. So too is the similarity of ornamental elements from another design (Figure 7), including the back to back animals, scallop shell, rosette and sprays of foliage. A ceiling design by James Gibbs is also of the same style, though undoubtedly one of much greater expense than the one executed at Belmont (Figure 8).

The robust quality of the boldly modelled elements of Belmont's ceiling are distinctive from the more delicate Rococo ceilings that comprise most of the remaining extant examples from the eighteenth century in colonial America. One of the earliest ceilings is in the hall of Westover in Charles City County, Virginia, which dates from c.1730-34 (Figure 9).²⁷ The decorative work here was probably imported from London along with the fireplaces in the house. Another ceiling that predates Belmont's is the one from the first floor drawing room of Drayton Hall in South Carolina (Figure 10).²⁸ This plasterwork is the only major decorative ceiling dating from the period of construction of the house c.1738-42. It has heavy moldings which delineate the composition of the ceiling, but the floral elements do not show the influence of the French Rococo as do those elements of the Belmont ceiling. Philipse Manor Hall in Yonkers, New York, c.1755, also has a Rococo ceiling, with ornamental elements possibly imported from England or France (Figure 11).²⁹ The Powell House in Philadelphia (1770) had a Rococo ceiling executed by the plasterer James Clow who had emigrated from England

²⁷ Pierson 78.

²⁸ William Bynum, *Drayton Hall: An Annotated Bibliography*, (Washington D.C.: Preservation Press, 1978) 33.

²⁹ John G. Waite, *The Stabilization of an Eighteenth Century Plaster Ceiling at Philipse Manor: A Restoration Report*, (NY State Historic Trust, 1972) 11.

in 1763 (Figure 12).³⁰ Removed from the building and reinstalled at the Philadelphia Museum of Art in 1925-26, Clow's ceiling has floral elements along the sides and in the corners, and groups of musical instruments in the center. To date there has been no documentation found that identifies the plasterer of the Belmont ceiling, however, the presence of James Clow in Philadelphia in 1770 and the fact that at least half a dozen plasterers were listed on the Philadelphia tax rolls for that year, suggests that the Belmont ceiling could possibly have been done by someone living in Philadelphia.³¹

³⁰ George B. Tatum, *Philadelphia Georgian: The city house of Samuel Powel and some of its eighteenth century neighbors*, (CT: Wesleyan University Press, 1976) 90.

³¹ Tatum 91. (It would be interesting to look at the Philadelphia tax rolls for the years around 1745 to see if any plasterers were listed yet.)

Figure 3 Reconstruction of original east facade of Belmont Mansion.
By Martin Jay Rosenblum, R.A. and Associates.



Figure 4 James Gibbs, design for a house, from *A Book of Architecture*, London, 1728.
In William Pierson, *The Colonial and Neoclassical Styles*, NY, 1970, p. 128.



Figure 5 Room 101 ceiling plan.
From 1992 Historic Structures Report.

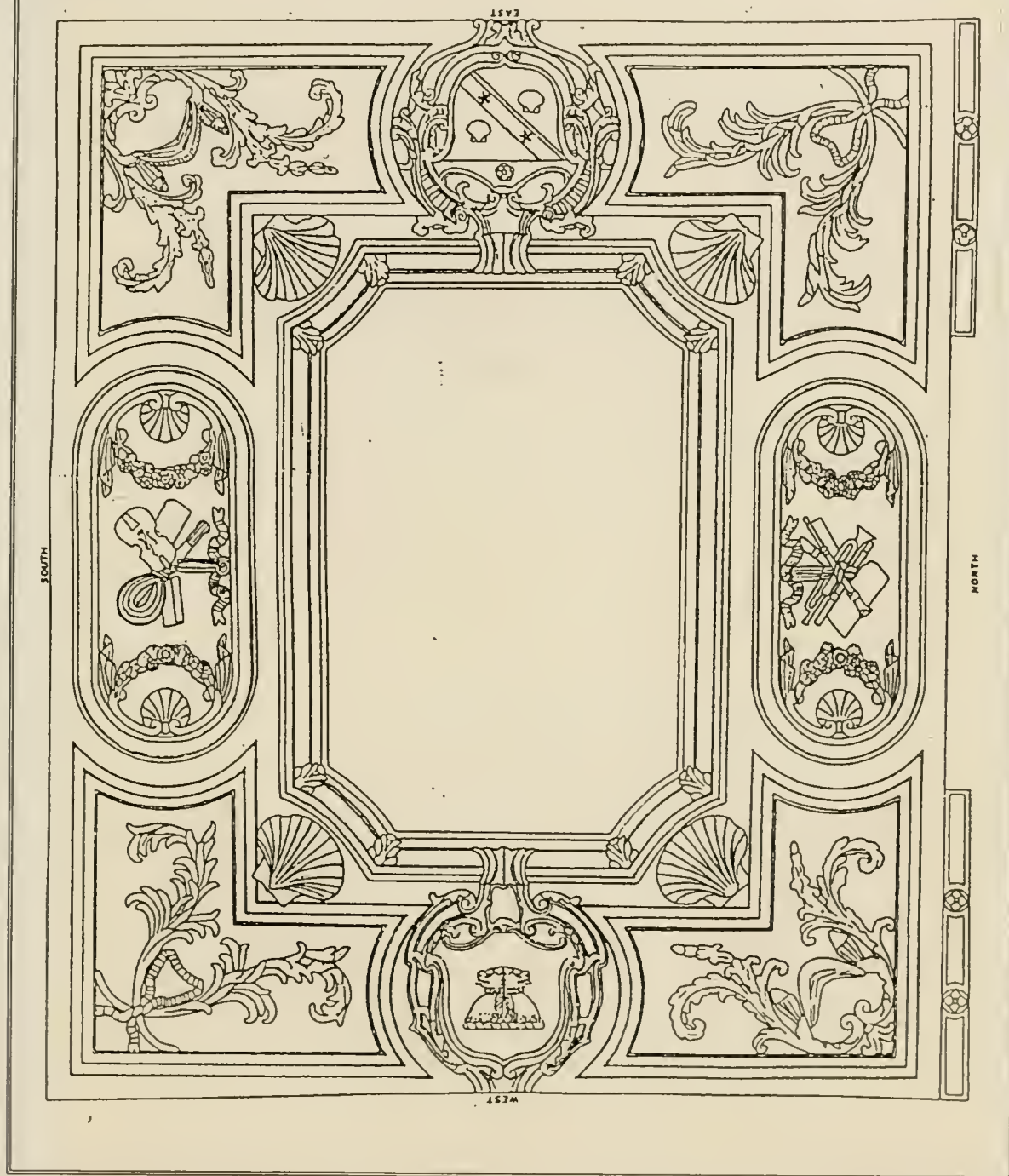


Figure 6 Batty Langley, design for a ceiling, from *Treasury of Designs*, London, 1745.



Figure 7 Batty Langley, design for a ceiling, from *Treasury of Designs*, London, 1745.

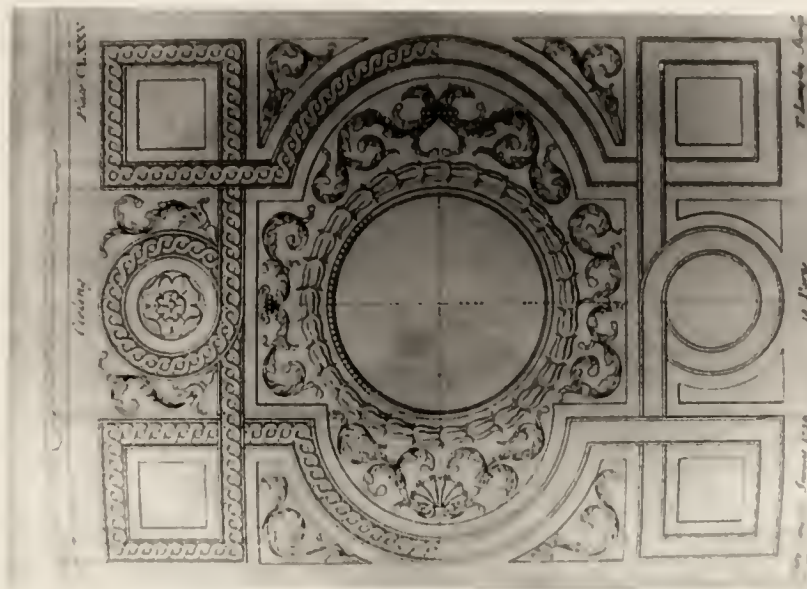


Figure 8 James Gibbs, design for a ceiling.

In Geoffrey Beard, *Decorative Plasterwork of Great Britain*. London, 1975, plate 51.



Figure 9 Westover, Charles City County, VA, hall ceiling c.1730-34.

In William Pierson, *The Colonial and Neoclassical Styles*, NY, 1970, p. 79.



Figure 10 Drayton Hall, SC, first floor drawing room ceiling c.1738-42.

In William Bynum, *Drayton Hall: An Annotated Bibliography*, Washington D.C., 1978, p. 33.



Figure 11 Philipse Manor, Yonkers, NY, room 103 ceiling, c.1755.

In John Waite, *Stabilization of an Eighteenth Century Plaster Ceiling at Philipse Manor, NY*, 1972, p. 11.



Figure 12 Powell House, Philadelphia, PA, second floor front room ceiling, 1770.

In George Tatum, *Philadelphia Georgian*, CT, 1976, p. 89.



4. HISTORICAL TECHNOLOGY

Understanding how a historic building or component of that building is constructed is essential to assessing the condition of that building, as well as undertaking informed, compatible interventions. This understanding includes a knowledge of the materials involved, how they were put together and perhaps most importantly, how they work together. It is therefore the responsibility of the architectural conservator to ensure that she/he has an understanding of the architectural system before proceeding with a conditions analysis or treatment development. Contemporaneous technological literature provides one primary source.

Joseph Moxon gave definitions of the plasterer's tools in his 1703 *Mechanick Exercises*. Richard Neve's *City and Country Purchaser's and Builder's Dictionary* also from 1703, and *Builder's Dictionary, or Gentleman and Architect's Companion* from 1734, have definitions for the tools and process of plastering, as well as ways of measuring and pricing work.³² *The New Practical Builder, and Workman's Companion* by Peter Nicholson from 1823 describes plastering technology and technique and also has "The Practical Builder's Perpetual Price-Book" in the back of the volume, which includes "Average Prices of Plasterer's Measured Works in England, Ireland and Scotland." Nicholson's 1846 *Practical Masonry, Bricklaying and Plastering* has more extensive text on plastering than his 1823 volume and although later, for this reason it is partially transcribed in Appendix A to give a more detailed description of laying up a plaster ceiling.³³ And of course, there is also William Millar's famous 1897 *Plastering: Plain and Decorative*, of which Trevor Howells rightly wrote, "Almost every writer on the

³²The text of these two books is identical, though the second one is listed without an author in the Park List.

³³*Handbook of Building Crafts in Conservation* by Jack Bowyer also includes a reprint of Peter Nicholson's 1846 *Mechanic's Companion*.

subject since (the turn of the century) owes a debt, large or small."³⁴ This study will primarily refer to these two volumes below, however, Nicholson's 1846 volume was found to be more easily digestible than Millar's encyclopedic tome, and that the changes in technology in the time period between the two makes Nicholson's text seem that much closer to the plaster technology of the date of Belmont.

The basic system of plastering: the plaster and the support it is keyed to, as well as the fundamental methods of applications, have remained largely the same from ancient times to the present. What has changed is the introduction of new plaster types and the construction of different supports. In eighteenth and nineteenth century structures from the European tradition, ornamental plaster ceilings employ a multi-layer system of rough base and finer finish plaster attached to wooden lathing strips. Wooden lath were split by hand prior to the mid-nineteenth century, when they began to be sawn more often by machine.³⁵ Nicholson stated, "wrought-iron nails are much to be preferred" to cast-iron nails, "which cannot be used with any degree of safety when the joists of the building are composed of oak," and that "to ceilings, or any description of work requiring strength, double laths ought always to be applied."³⁶ Millar suggests the laths should be fixed 3/8

³⁴Trevor Howells. *The New and Compleat Gentleman and Architect's Guide to the Conservation of Decorative Plasterwork*, York: 1980, Introduction.

³⁵William Millar, *Plastering Plain and Decorative*, (NY: Truslove & Comba, 1897) 85.

³⁶Peter Nicholson, *Practical Masonry, Bricklaying and Plastering, Both Plain and Ornamental*, (London: Printed for Thomas Kelly, 1847) Chapter IV, No. 346.

The appendix to Millar's *Plastering Plain and Decorative* includes the following: 1. PLASTERER'S MEMORANDA, QUANTITIES AND WEIGHTS

LATHS - Length, from 2 ft. 6 in. to 4 ft., Width, about 1 in., Thickness - Single laths, 1/8 to 3/16 in., Lath and a half, 3/16 to 1/4 in., Double laths, 1/4 to 3/8 in. Laths are usually spaced from 1/4 to 3/8 in. apart, according to their strength and nature of plaster. Lathing nails are from 3/4 to 1 1/4 in. long, according to the thickness of the laths.

inch apart to allow for enough plaster to be extruded through the space to form a strong key.³⁷

Plaster used to create the flat surface for ornamental ceilings traditionally was made of lime, sand, animal hair and water. Numerous terms exist for the materials, tools and steps of plastering that vary regionally and nationally. Lime plaster is called by the many names of mortar, course stuff, and lime and hair, and is used in a three-coat system which consists of first-coating, floating, and setting.³⁸ The American term for the first-coat is *scratch-coat*, while Nicholson used the London term, *pricking-up*. For ceilings, this first layer is spread diagonally across the laths, overlapping each trowelful. After letting the first-coat stand for an hour or so, it is scored to provide a key for the following coat. The *floating coat* is laid upon the first-coat, forming a straight surface for the *setting coat* through the use of screeds and a floating rule, (see Appendix A for more detailed description of floating).³⁹ The *setting*, or *finish coat* is made of pure slaked lime, or lime putty, and mixed with washed fine sharp sand or well-beaten white hair. It is applied once the floating coat is firm and nearly dry, but not too dry as this will cause the setting coat to crack and peel.⁴⁰

While lime plaster is used to form the flat base for ornamental ceilings, "plaster of Paris is the composition on which the plasterer materially depends for giving precise form and finish to the decorative part of his work; by its aid he executes all the ornaments applied to ceilings and cornices."⁴¹ Decorative elements were either worked up by hand

³⁷ Millar 85.

³⁸ Millar 90.

³⁹ Millar 91-92.

⁴⁰ Nicholson, Chapter IV, No. 351.

⁴¹ Nicholson, Chapter II, No. 337, pg 181. However, Historic Scotland Technical Advice Note 2, "Conservation of Plasterwork," states that lime stucco work generally predates the late eighteenth century and that "in situ freehand modelling, especially rococo work, will almost invariably be in lime stucco rather than gypsum," page 23.

in situ or on slabs or plaques and then fixed to the ceiling, moldings were run in place or on a workbench with a template, and later, ornaments were cast in molds at the workshop. Both Nicholson and Millar extensively explain molding in wax and molding in plaster, as these methods had almost entirely replaced hand modelling by the time they were writing their texts. Nicholson explains:

The forming of ornaments of every description in their proper places, by means of suitable tools, commonly called "Hand Ornament Working," is at the present day but partially practised, having been, in a great measure, superseded by the invention of cast-work; but, not withstanding, we think it necessary, to advert to it.⁴²

When hand modelling the ornament, "according to the method practised by the old Italian stucco-workers," the first step is to draw the design of the ornament where it is to be placed on the ceiling, next it is boasted, or "got out in the rough with gauged fine stuff." This is followed by a thin coat of ornamental stucco which is worked into the proper shape and finished, "with the assistance of small steel tools of various sizes and patterns."⁴³ Millar describes the process with some additional detail that includes cutting the surface to form a key for thick or deep parts of the design, or just roughing up the surface for thinner or lighter ornaments. The attachment of heavier details may be strengthened by inserting nails or screws into the wood work on ceilings or the joists, with a few flat-headed nails being sufficient for most purposes.⁴⁴ For extra heavy ornaments, or those "intended to have a great emboss or projection from the ground," long wrought iron nails with tarred-twine twisted round them must be driven into the timbers.⁴⁵ In England throughout the sixteenth and seventeenth centuries, plasterwork was usually finished white or off-white. This practice continued until the mid-eighteenth

⁴²Nicholson, Chapter IV, No. 367, pg 197.

⁴³Ibid.

⁴⁴Millar 244.

⁴⁵Nicholson Chapter IV, No. 367, pg 197.

century, with the exception of occasional examples of gilding, when colors became more prevalent with the complete decorative schemes by Robert Adam, Sir William Chambers and James Wyatt from about 1760 onwards.⁴⁶

⁴⁶Geoffrey Beard, *Decorative Plasterwork in Great Britain*, (London: Phaidon Press, 1975)19.

5. CEILING CONSTRUCTION

The ornamental ceilings at Belmont are of the construction outlined above, course stuff and finish plaster keyed to wooden lathing strips that are nailed to the floor joists above. The lath are hand split, often called rent lath, and on average are 3/16" (3-5 mm) thick by 1 1/8" (28 mm) wide, though some range in width from approximately 3/4" (20 mm) to 1 1/2" (38 mm). They are secured with 1" wrought nails with rose heads, very often to nailers attached to the undersides of the joists to allow for adequate space for the plaster to create a key under the joist. The space between the lath for the plaster keys is uneven due to the variable widths of the hand split wood.⁴⁷ The course stuff from the room 101 ceiling is 1/2" (7-10 mm) thick with sand, lime (often as blebs or lumps) and animal hair, and the finish plaster is 1/16" (2-3 mm) thick.

The ornamental elements are made of built-up finish plaster. This relief work can be divided into three categories: lower relief, which includes the floral elements, swags, cartouches, and small moldings; high relief, which includes the larger moldings and instruments; and super-high relief, which includes the four scallop shells and the violin. Comparison of the same elements of relief work reveals subtle differences in the ornament. The best illustration of this is a comparison of the matching ribbons in the northeast and southwest corners of the ceiling (Figure 13). These subtle differences are the result of hand modelling, and as such have, "the charm of variety which cast plaster never possessed".⁴⁸ Likewise, the matching concave and convex shells are also slightly different. Considering the size of the shells, their projection and the amount of detail on

⁴⁷Millar compared hand split lath with machine cut, saying: "Those split by hand give the best results, as they split in a line with the grain of the wood, and are therefore generally stronger, and are not so liable to twist as machine made." Page 85.

⁴⁸Millar 230.

the back side, it seems more likely that they would have been modelled by hand on a slab and then attached to the ceiling, rather than modelled in place (Figure 14).

Wrought iron nail tips are visible from above the ceiling when looking at the plaster keys and lath (Figure 15). They appear in single rows of about three to five nail tips. As recorded on the key condition drawing and overlaid with the ceiling plan, they generally coincide with the large moldings. Excavation of a crack (S2 on the keyed illustration) revealed a sectional view of the construction of the molding that is consistent with the descriptions given by both Nicholson and Millar. The molding is built up of finish stuff, with a wrought nail extending down into it as a key. An additional construction detail visible in the lath work above the hall ceiling is a series of small wedges, each pushed under a lath, thus resting on the laths on either side (Figure 16). This results in the middle lath being pushed up and more plaster being able to push up through the larger space to create a substantially larger key. Similar to the nail tips, this detail appears in clusters, however, it does not coincide with any particular ornament.

Figure 13 Comparison of ornaments in northeast and southwest corners.

Note the subtle difference in the ribbons which is a result of hand modelling in situ. Martin Jay Rosenblum, R.A. and Associates, 1990.



Figure 14 Detail of southeast corner shell.

Considering the size, projection and detail of the shells, they were probably modelled by hand on a slab and then attached to the ceiling.



Figure 15 Detail of nail tips, room 201.

The nail tips that are visible in rooms 201 and 202 coincide with large moldings in the ceiling below.



Figure 16 Detail of a lath wedge, room 201.

Small wedges pushed under lath help to create larger plaster keys.



6. PHYSICAL INVESTIGATION

Physical investigation of the ceilings involved three levels of inquiry: materials characterization, conditions survey and deterioration diagnosis. Materials characterization included identification of the general layer structure and composition of the plasters and paints. The conditions survey provided a systematic recordation of the existing conditions of the ornamental plaster (over time where possible), the lath and plaster key attachment system, and the framing members that make up the structural support for the ceiling. Deterioration diagnosis synthesized the information gathered in order to identify the intrinsic and extrinsic mechanisms of deterioration affecting the plasterwork and to make recommendations for treatment testing.⁴⁹

6.1 MATERIALS CHARACTERIZATION

6.1.1 PLASTER ANALYSIS

The plaster samples for room 101 came from two fragments of plaster that had been removed for the installation of the scaffolding where it supports the summer beam and fireplace trimmers. These pieces provided enough plaster to perform gravimetric analysis on the rough and finish coats to determine the basic formulation and to isolate the aggregate for comparison. Three samples of the rough coat plaster and two samples of the finish coat plaster were analyzed. This consisted of powdering the sample with a mortar and pestle, digesting the acid soluble fraction in a 15% solution of hydrochloric acid and separating out the fines by levigation from the remaining aggregate. The aggregate was then sieved to determine particle size distribution and the filtered fines were tested for gypsum by microcrystalline analysis. Plaster from the room 205 ceiling

⁴⁹Excluded from this discussion of deterioration factors is the interior climate of the building, as the temperature and relative humidity was not monitored during the conditions survey.

was not subjected to gravimetric analysis because there was insufficient material available. One small sample was taken for cross sectional examination.

Plaster samples from both ceilings were mounted in a commercial polyester acrylic resin (Bioplast), cross sectioned, and viewed with a stereomicroscope (Nikon SMZ) under reflected visible light to identify their general visual characteristics such as stratigraphy, color, texture, binder distribution, aggregates and other inclusions. A thin section of the room 101 plaster was viewed in polarized light to identify the mineralogy of the aggregate.⁵⁰ Elemental analysis of both samples was also performed with scanning electron microscopy/energy dispersive x-ray (SEM/EDX).⁵¹

Visually the plaster samples from the two ceilings look very similar (Figs. 17 and 18). The rough coats are a light brown color, of a medium coarse texture, and contain aggregates of similar appearance and grain size distribution. The most noticeable difference between the two plasters is that the lime binder in the room 101 plaster is thoroughly mixed or dispersed within the matrix thus giving it a uniform color, while in the room 205 plaster numerous lime blebs are distinctive within the matrix, resulting in a slightly darker brown color than the room 101 plaster. Gravimetric analysis of the rough coat plaster samples revealed general consistencies in the type and amount of aggregate and acid soluble fraction. Thin section examination in polarized light identified the aggregate as a decomposed schist made of quartz, muscovite and biotite, which is similar to aggregates found in other local eighteen century mortar and plaster samples, suggesting a nearby source. The finish coat of the room 205 plaster has a very fine homogenous texture and white color with a few light brown inclusions. The finish coat of the room 101 plaster is not as fine or homogeneous as the room 205 plaster. It too has

⁵⁰ Qualitative analysis of mineralogy performed by Dr. Gomaa Omar, Assistant Professor of Geology, University of Pennsylvania, April 1996.

⁵¹ Qualitative analysis of elemental composition performed by Dr. Rollin E. Lakis, Research Scientist, Laboratory for Research on the Structure of Matter, University of Pennsylvania, April 1996.

occasional light brown inclusions, but it also has lighter looking rounded areas (Fig. 19). These areas, when viewed in thin section with polarized light, are darker than the surrounding material and appear to be a change within the matrix, (i.e., an alteration), because they are not distinct grains but rather have the same visual appearance as the surrounding matrix. Thin section examination of the finish plaster also showed less than 1% fine clear sand, which was again confirmed by the gravimetric analysis results. Plasters from relief ornament on both ceilings (samples 2S2, S4 and S5), however, do have a significant amount of clear sand included (Figure 20). The fines from the gravimetric analysis of the finish plaster from room 101, tested negative for gypsum.

There are no distinctly visible layers in the room 101 rough coat plaster and there is no physical separation occurring within it, as it is cohesive and very hard. It is also difficult to separate the finish coat from the rough coat. The room 205 rough coat plaster is also hard, with no apparent separation within the material occurring. The presence of distinct application layers, however, was confirmed with SEM backscatter imaging. One finish coat and three rough coat layers, which are subtly different, are visible in Figures 21 and 22, which together comprise a complete section of the plaster sample. SEM/EDX analysis of the two plasters identified calcium and magnesium, suggesting use of a dolomitic or calcium-magnesium carbonate lime. Trace amounts of sulfur were also tagged by EDX throughout the rough and finish coats of the room 205 plaster, and in the low-relief work of the east cartouche and super-high relief southeast shell of the room 101 ceiling (samples S4 and S5). A significant amount of sulfur was identified in the high relief molding on the north side of the northwest panel (sample S2) and the replacement plaster keys above it in the northwest end of room 201 were identified as entirely calcium and sulfur (gypsum). Generally, a slightly greater level of sulfur was seen in the high relief ornaments in comparison to the low relief work. The presence of gypsum or plaster of Paris as an original additive component to the lime plaster would be

expected in both hand modelled and bench cast high relief elements to enhance setting and crispness of detail.⁵²

6.1.2 PAINT ANALYSIS

Analysis of the ceiling's painted finishes was undertaken to identify and characterize the general stratigraphies and composition of the finishes applied to the plasterwork over time. Compositional analysis focused on the identification of the white pigments in the paints, as they often reflect chronological changes in paint technology and thus provide relative dating. Eighteen samples from the flat plaster and relief work of both ceilings were taken to establish the standard/complete stratigraphy and to identify the presence of any decorative painting. Out of the original sample group, two representative samples (S3, S5) were then analyzed using normal reflected and Ultraviolet fluorescence microscopy and SEM/EDX. Normal reflected light microscopy was used to observe the visual characteristics of the paint layers. UV fluorescence microscopy was used to observe the auto- or primary fluorescence of the pigments and media in the different paint layers. (Primary fluorescence is the property some substances have of emitting fluorescent light when excited with ultraviolet radiation.⁵³) SEM/EDX was employed to help identify the elemental composition of the pigments in the different layers and thus infer the use of certain pigments. The back-scatter electron mode of the SEM produces an image in tones of whites and grays that show the pigments with the highest atomic number as the brightest tones.⁵⁴ The locations of the identified elements were then recorded with digital x-ray mapping, which produced separate maps for the

⁵² Peter Nicholson, *Practical Masonry*, Chapter II, no. 335.

⁵³ Marie L. Carden, "Use of Ultraviolet Light as Aid to Pigment Identification," *APT Bulletin* 23, no. 3 (1991): 27.

⁵⁴ Eugene Farrell, "Pigments and Media: Techniques in Paint Analysis," in *Paint in America*, ed. Roger W. Moss (Washington, D.C.: Preservation Press, 1994), 198.

locations of the individual elements thus illustrating the elemental stratigraphy of the paint layers.

For both samples, the paint layers can be divided into three overall groups with distinct visual qualities (Figures 23 and 25). The first group is comprised of the layers closest to the finish plaster. Group 1 has from eight to ten layers that appear somewhat translucent to opaque in reflected light. On top of this group is a dark brown layer that looks like a resinous layer. Group 2 is comprised of thirteen layers of paint that have a more uniform and dense appearance and colors that range from off-whites and creams to pale yellows, and two layers of a distinctive green color. In this group, some of the samples had a significant amount of dirt between the layers, while others had none. All the samples that had a complete stratigraphy, from both ceilings and from flat areas as well as relief areas, had the same sequence of layers which effectively eliminated the possibility of decorative painting.⁵⁵ Group 3 is comprised of three to four layers and is characterized by thick bright white layers with numerous large vacuoles typical of emulsion (latex) paints. There is also a fracture between the first and second layers in this group in many of the samples. In UV light, the autofluorescence of the layers is again distinctive within the same three groups (Figures 24 and 26). The bottom group displays a translucent lower level of fluorescence typical of calcium carbonate (lime) while the second group, displays a higher level pale to bright yellow fluorescence characteristic of zinc oxide.⁵⁶ The back-scattered electron image from the SEM/EDX analysis also shows three distinct groups (Figures 27 and 28), with the second group having the brightest tones and thus the elements with the highest atomic numbers such as lead and zinc (see below).

⁵⁵ One photograph of room 101, in *Byways and Boulevards In and About Historic Philadelphia* (1913), looks like the ceiling has a two-tone or Wedgwood like paint scheme, but I was not able to find definite evidence of it in the paint samples.

⁵⁶ Carden 28.

EDX/digital x-ray mapping identified the top layer of the first group as calcium and the rest of the layers as calcium and magnesium. This suggests that these finishes may be limewashes or whiting-based distempers, (analysis of organic binders was not performed). The presence of magnesium in the bottom layers of the first group strongly indicates the use of a dolomitic lime, like the rough and finish coat plaster beneath it, and thus suggest use of a limewash.⁵⁷ The elements identified in the second group include lead, zinc, barium and titanium. *Lead whites* (basic lead carbonate) used as paint pigments have been in existence since classical antiquity, and were used extensively in oil based architectural paints until laws were passed in 1960 prohibiting their use. The presence of lead in paint therefore only helps to end-date later layers to the 1950s.⁵⁸ *Zinc oxide*, however, became more economically competitive with lead paints about 1850 in America, thus providing a possible base date for paints with zinc.⁵⁹ Leaded zinc oxide “was widely used in house paints from the mid-nineteenth century until the introduction of *titanium white* around 1920.”⁶⁰ The first layer of the second group was identified as lead and zinc, followed by four layers with lead.⁶¹ Since the first layer of Group 2 is probably an oil-based paint, the presence of the resinous looking layer between the suspected distemper or limewash layer and oil-based layer is not surprising. This coating

⁵⁷ Morgan W. Phillips, “A Survey of Paint Technology: The Composition and Properties of Paints,” in *Paint in America*, ed. Roger W. Moss (Washington, D.C.: Preservation Press, 1994), 241.

⁵⁸ Andrea M. Gilmore, “Analyzing Paint Sample: Investigation and Interpretation,” in *Paint in America*, ed. Roger W. Moss (Washington, D.C.: Preservation Press, 1994), 180.

⁵⁹ Carden 26.

⁶⁰ Carden 28.

⁶¹ The fact that the first lead paint on the plasterwork is possibly a leaded zinc oxide that would have a base date of c.1850 has interesting implications in the history of the ceiling and the house, as it was in 1848 that Belmont went into the hands of the trustee of Judge Peter’s estate. During this time the commercialization of Belmont continued, including the transformation of the mansion into a boarding house and the addition of the third floor.

is probably a resin varnish or glue size applied as a sealer to isolate the limewash/distemper layers from the later paints and to ensure good adhesion.⁶²

The layer above the four consecutive lead layers is another zinc one, but this time it occurs with barium and/or titanium. One pigment possibility for this layer is *lithopone*, also called *Griffith's zinc white*, which is a mix of zinc sulfide and barium sulfate and was introduced to the American paint market in linseed oil c.1901.⁶³ Another possibility is *titanated lithopone*, which was used through the first half of the twentieth century for interior house paints.⁶⁴ The next layer that occurs with barium and/or titanium does not have zinc. This could be a layer with *titanium white* (titanium dioxide) because *barium white* (barium sulfate) “was frequently combined with titanium white for interior house paints,” which would put this layer after c.1920.⁶⁵ The third and most recent group of paints, which probably dates from after c.1960, has titanium, aluminum and calcium (the latter probably used as an extender). In summary, Group 1 is comprised of eight to ten layers of limewashes or distempers, and dates from the mid-eighteenth century to probably the mid-nineteenth century. Group 2 has an average of thirteen layers which are predominantly lead based, with a few later ones having barium and titanium. Thus this group roughly spans from the mid-nineteenth century to after the 1920s and has the highest rate of repainting, but also incidentally, the greatest amount of dirt between layers. Finally, the last group has three to four thick paint layers that would date from the 1920s to the most recent repainting of the plasterwork.

⁶² Brian Powel, “Painting Techniques: Surface Preparation and Application,” in *Paint in America*, ed. Roger W. Moss (Washington, D.C.: Preservation Press, 1994), 217.

⁶³ Carden 27.

⁶⁴ Carden 29.

⁶⁵ *Ibid.*

Figure 17 Photomicrograph cross-section, plaster sample S1.
(magnif. 12.5x)

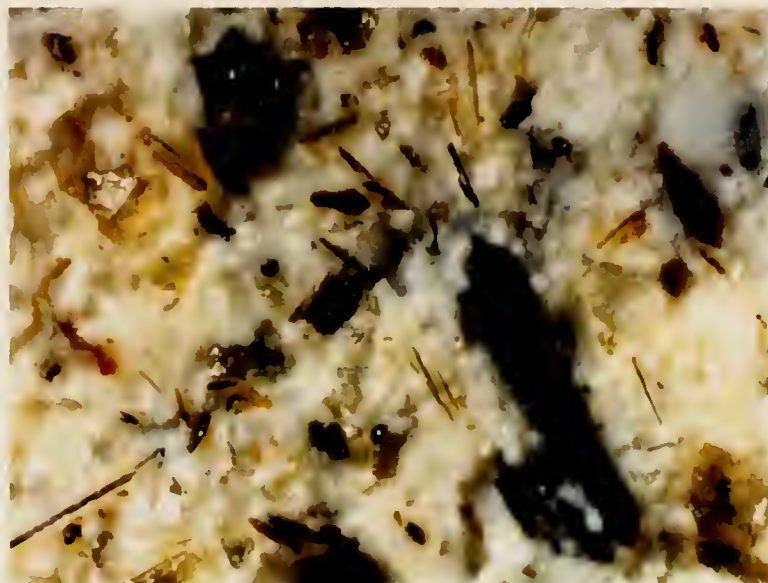


Figure 18 Photomicrograph cross-section, plaster sample 2S1.
(magnif. 12.5x)

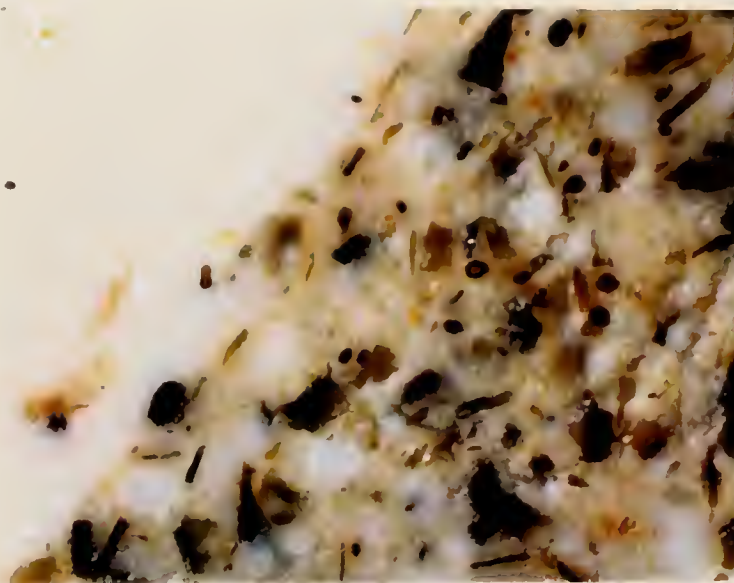


Figure 19 Photomicrograph cross-section, finish plaster, sample S1.
(magnif. 12.5x)



Figure 20 Photomicrograph cross-section, finish plaster, sample 2S2
(magnif. 12.5x)



Figure 21 Backscatter electron image, sample 2S1.
(magnif. 20x)



Figure 22 Backscatter electron image, sample 2S1.
(magnif. 20x)



Figure 23 Photomicrograph cross-section, paint sample S3.
(reflected light, magnif. 12.5x)

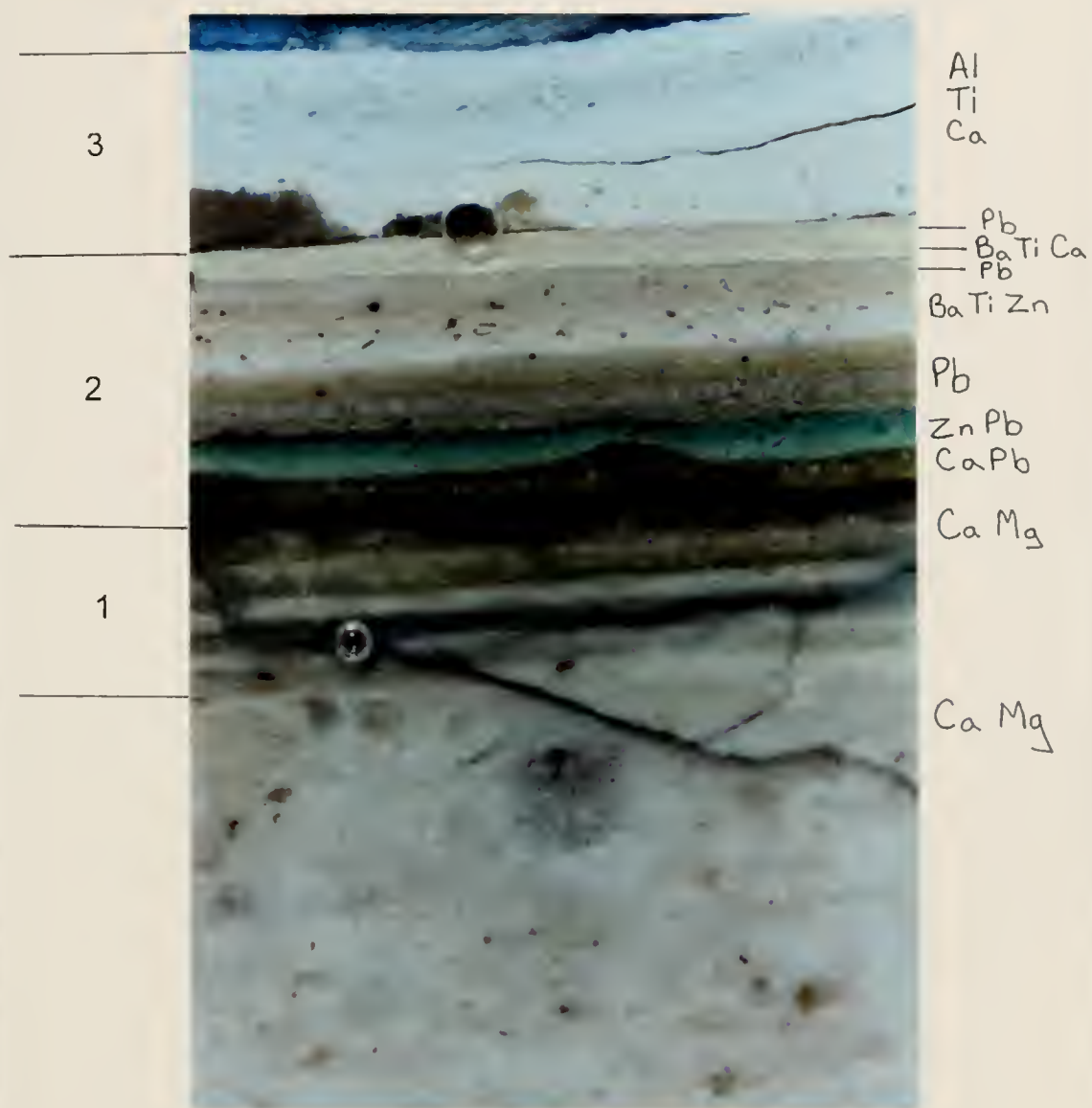


Figure 24 Photomicrograph cross-section, paint sample S3.
(UV light, magnif. 12.5x)

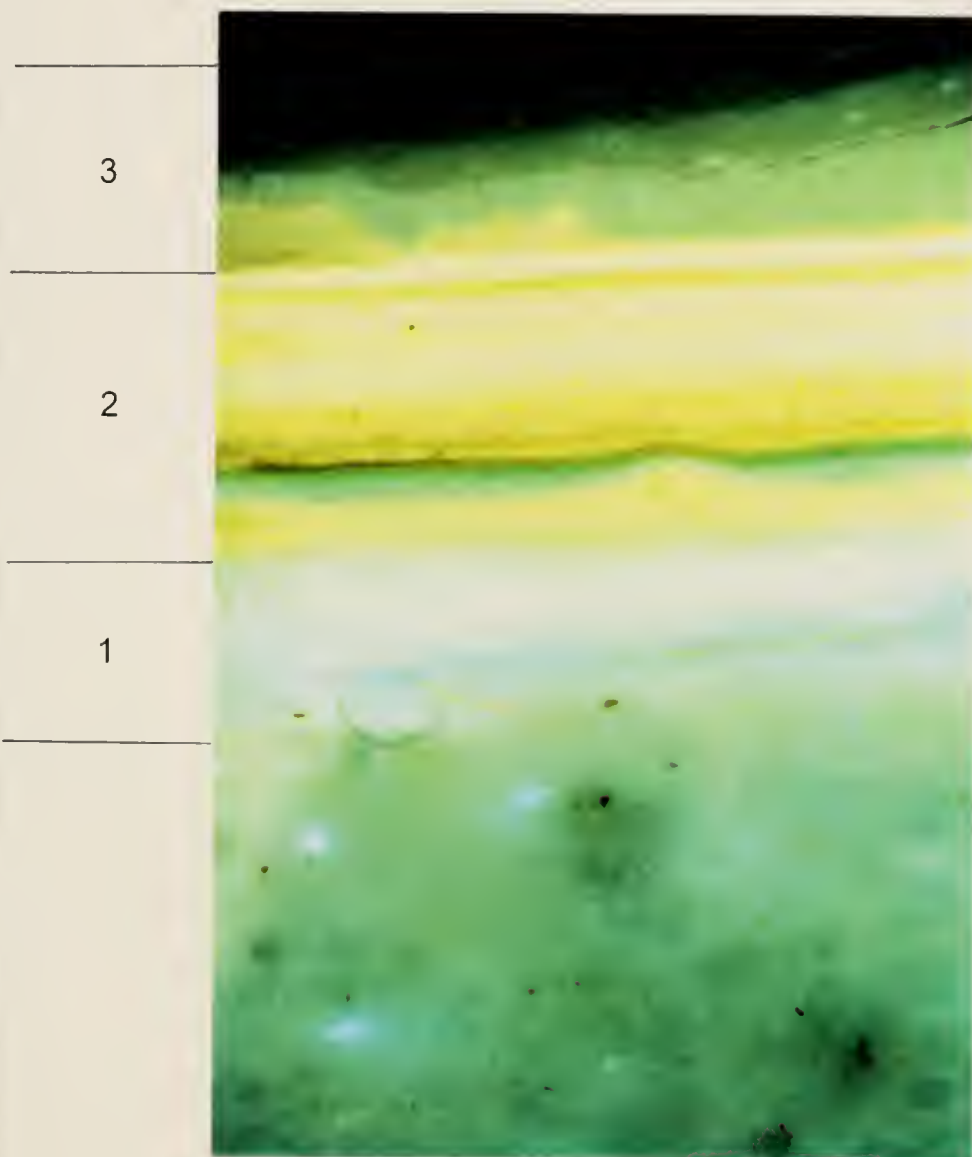


Figure 25 Photomicrograph cross-section, paint sample S5.

(reflected light, magnif. 12.5x)

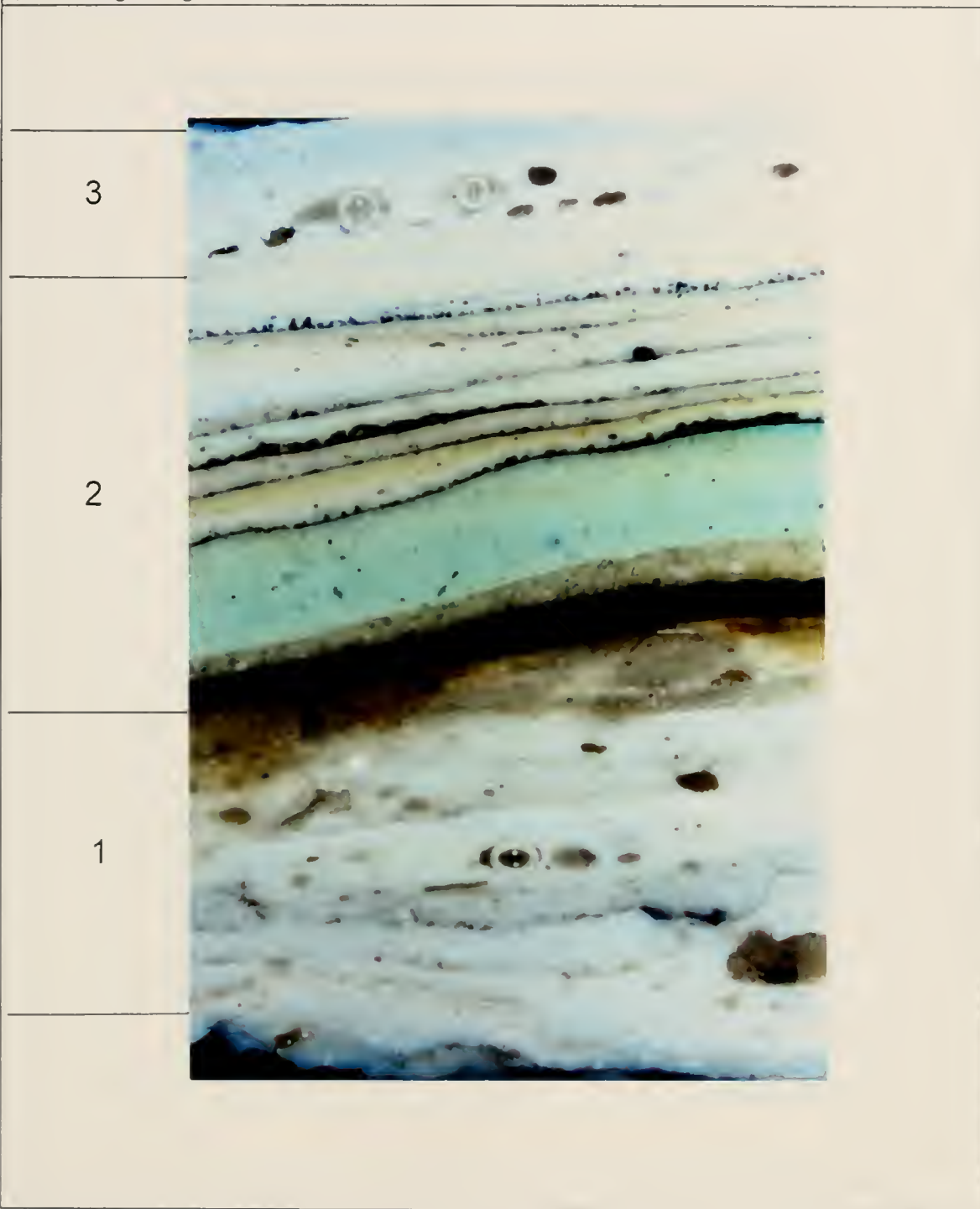


Figure 26 Photomicrograph cross-section, paint sample S5.
(UV light, magnif. 12.5x)

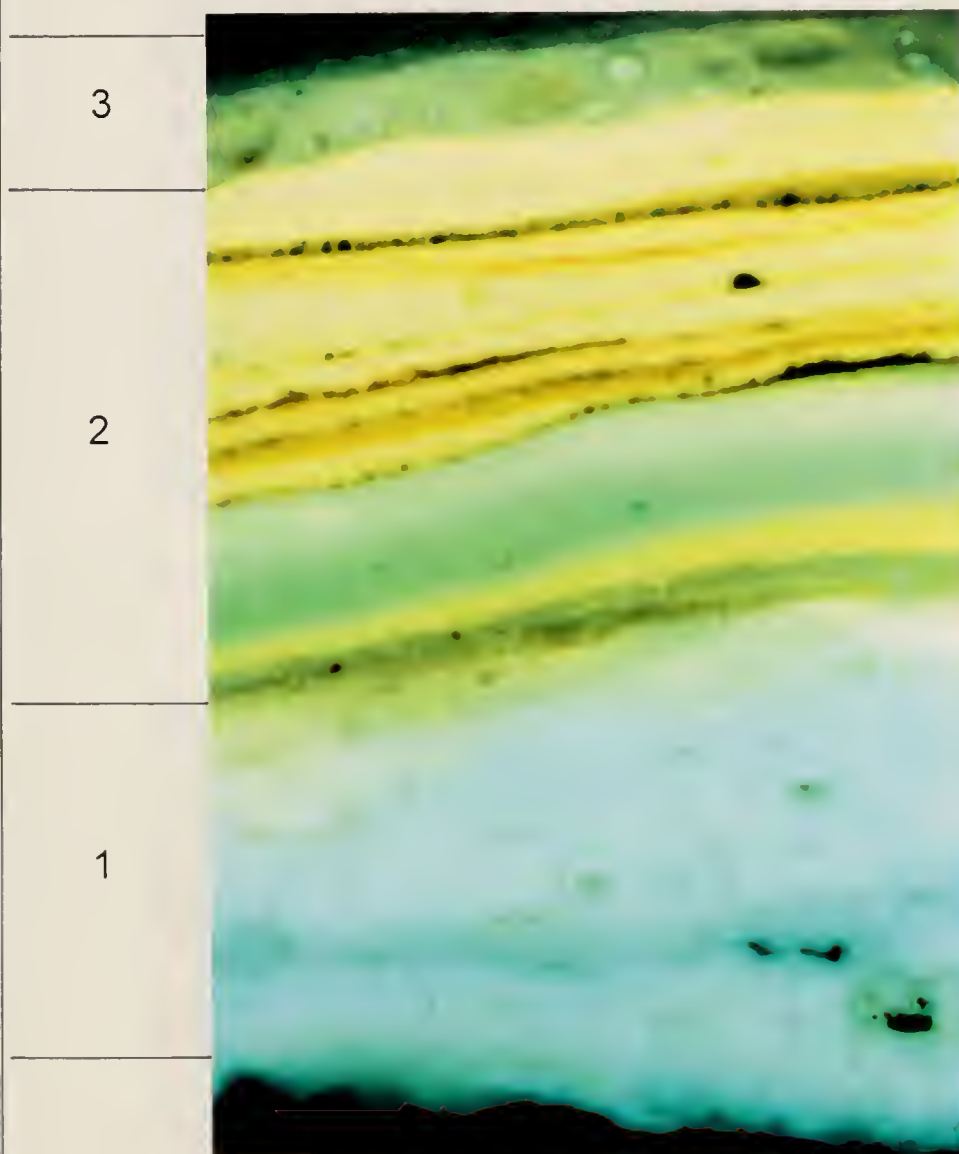


Figure 27 Backscatter electron image, paint sample S3.
(magnif. 33x)

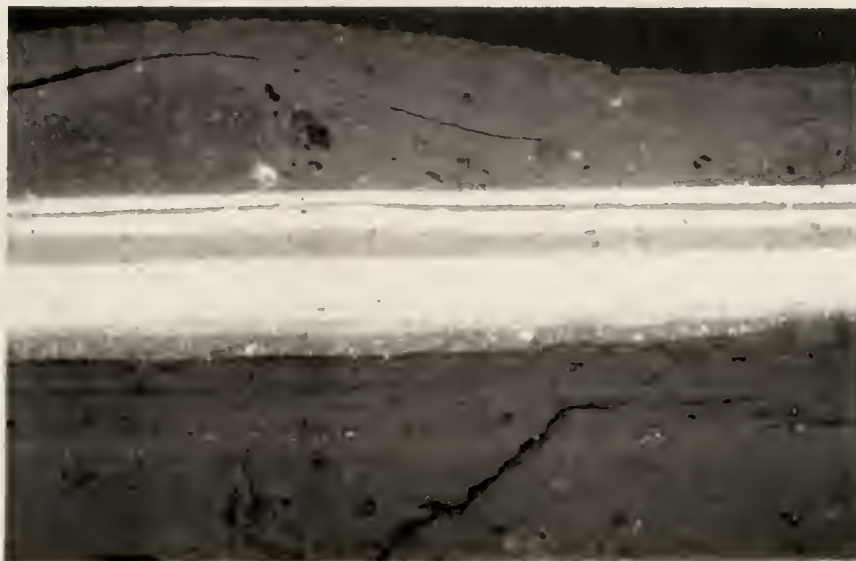
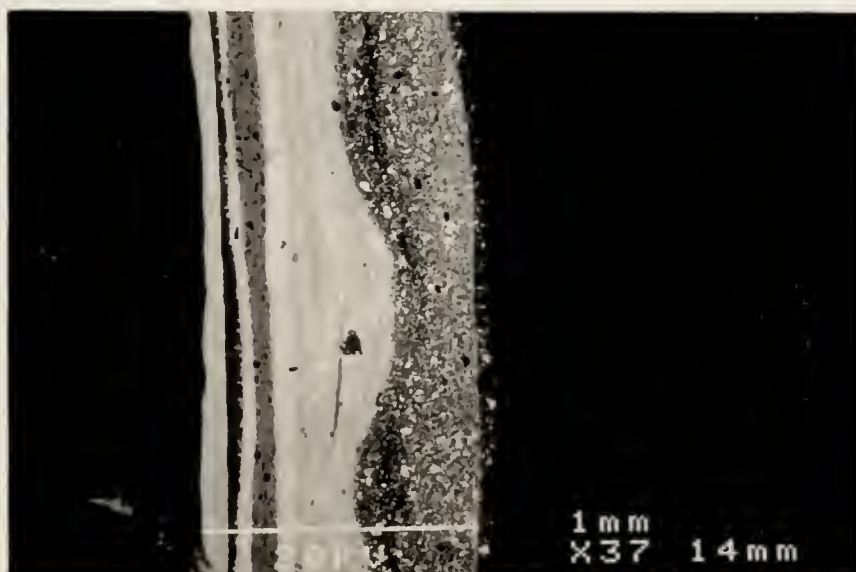


Figure 28 Backscatter electron image, paint sample S5.
(magnif. 37x)



6.2 CONDITIONS SURVEY

As previously stated in the methodology, the purpose of the conditions survey is to record the type, extent and degree of deterioration observed in the ceilings. The existing conditions of the ceilings in rooms 101 and 205 were identified, categorized and recorded using the same methodology employed for the Drayton Hall project. Wherever possible, the same definitions and graphic symbols were used to identify and record the conditions of the ceilings. The conditions recorded on the ceiling plans fall into the following categories: **plaster cracking**, **vertical displacement**, **patching**, **loss of plaster**, **staining**, **paint failure** (room 205 ceiling only), **broken or inadequate plaster key**, **detachment**, **joist cracking** and **partially withdrawn tenon**. These conditions are defined and illustrated at the end of this section in a glossary that includes the graphic symbol used to record each condition on the survey drawings and a photographic example from one of the ceilings (Figure 29).

6.2.1 ORNAMENTAL PLASTER CONDITIONS

Access to the surface of the plasterwork for inspection was achieved by scaffolding that had been erected to support the ceilings during construction on other parts of the building. The close-up inspection consisted of graphically recording the visible existing conditions with symbols and notations onto HABS plan drawings of the ceilings. The moldings and relief ornaments were also gently tested to locate any loose elements. From the floor level in room 101 two conditions are easily visible, the large open cracks that run through the decorative parts of the ceiling, and the ornamental relief work that has lost its detail to an accumulation of paint. One condition relates to structural distress and the other affects one's aesthetic appreciation of the ceiling; the first is a deterioration of material and the second a deterioration of the quality or value of the visible detail, however, paint accumulation may also be hiding failures, repairs and modifications to the plasterwork and ceiling. Both of these types of deterioration were

recorded in the survey but only those conditions that directly relate to the material deterioration of the plasterwork have been represented on the final conditions drawings (Figures 30-32).

The following observations of the condition of the plasterwork are drawn from the cumulative data recorded during the investigation. The surface condition of the plasterwork is characterized by muted detail and a considerable amount of unevenness surrounding the ornamental relief work, often concentrated where the relief work meets the flat plaster. An accumulation of about 25 layers of paint is known to be the cause of the loss of ornamental detail. The appearance of the uneven surface is that of a combination of lost and accumulated layers (Figure 33). It is very likely this surface texture is a result of numerous layers of paint, each new coat being added because some of the existing had failed. It is also possible the uneven surface is due at least in part to repairs attempting to fill cracks or reattach loose relief work. There are some cases in which it is obvious there has been a repair, these include (in room 101), the center of the ribbon detail in the northeast corner of the ceiling, and along the two large cracks on the south side of the center cartouches (Figure 34). The question of loose ornaments is in fact currently not a problem; there also appears to be no ornamental elements missing.⁶⁶ The bond between the flat plaster and the relief ornament was found in both ceilings to be very strong as there were no instances of the ornament being loose when tested. This held true even when a large crack went through both the flat and relief plaster. In light of these facts it can be concluded that the uneven surface is more likely to be an accumulation of paint than a repair trying to fill a crack or reattach an ornament, however,

⁶⁶The only piece of ornament missing is the neck and scroll of the violin, but through photographic evidence this appears to have been missing since the 19th century. Four sections of the flat plaster were removed with the installation of the scaffolding. Two larger squares were cut out beneath the deflected summer beam so that could be supported directly by the scaffolding, and a small square was cut out beneath each of the fireplace trimmers (the joists that support the fireplace header) so they too could be supported directly by the scaffolding.

this can only be proven by undertaking a number of test explorations to clarify the anatomy of this surface texture.

The condition of the paint is very different in room 101 than in room 205. In room 101 there is no peeling of the paint, as it is either adhered to the plaster or it is not. In other words, where the paint is not adhered to the plaster, it retains the shape of the relief ornament but there is a separation between the two. While map cracking of the paint is not present in room 101, it is the predominant condition in room 205. In both rooms, the failed paint is cleaving at a brown varnish-like layer that looks as if it is at the level of the finish plaster. Similar paint stratigraphy can be observed in both rooms, being predominantly whites and creams, with a distinct layer of light greens in the middle. When the paint is removed down to the finish plaster, the revealed detail of the relief ornament is exquisite and the exposed ornamental plaster beneath the paint is very hard. There is no efflorescence visible on either ceiling and no staining in room 205.

In October when the plaster survey of the east end of the room 101 ceiling was done, there was a small amount of staining visible along the east/west crack in the northeast corner, and a few small areas on the shield in the center cartouche. In December a radiator on the third floor broke and sent water washing down the east wall, however there was no water damage to the ceiling visible from the floor or scaffolding at that time. A few days after a driving rain storm in mid-March, new staining was noted on the cornice and ceiling between the door and south window of the east wall. Inspection from the scaffolding, this time removing the netting, revealed extensive water damage to the ceiling. The staining runs along the crack on the south side of the cartouche and adjacent relief work. A few new cracks are visible, and existing ones in the area are substantially longer.⁶⁷ The netting and wooden pieces of the scaffolding are also stained

⁶⁷These cracks could either be a result of the water damage or they could be existing cracks that are now visible because they were washed out by the water.

along the crack. From the pattern of staining, it is obvious that the water traveled along the summer beam and down the east scaffolding post that is supporting the beam, dripping through the cracks in the plaster along the way. For this amount of water to come through the plaster, the source would have to have been the broken radiator. Nevertheless, the presence of staining in this area prior to the broken radiator, and the appearance of staining along the cornice and adjacent plaster after a driving rainstorm would suggest that there is ongoing water infiltration from another source along the east wall.

The structural condition of the plaster is characterized by a series of large and small cracks that reflect deterioration caused by movement of the ceiling's support. Two distinguishable categories of cracks were identified in the survey based on width: cracks that are greater than or equal to 0.40mm, and cracks that are less than or equal to 0.30mm. The first category is easily visible and appears as large open cracks (horizontal displacement); the second category appears as hairline cracks in the paint. In room 101 there are six large open cracks of significant length that run east/west and three that run north/south. They range in width from 0.40mm to 5.0mm and all but one are accompanied by some degree of vertical displacement, in which the plaster surface on one side of the crack is lower than on the other side. The cracks from the two categories appear to go through the entire depth of the plaster. Hairline cracks in both ceilings run east/west and north/south sometimes intersecting perpendicular to each other and sometimes just branching off. When multiple paint layers are removed from these cracks they are consistently much larger underneath, indicating a substrate condition that has been translated to the overpaint. The consequence of this is that the finer surface cracks should not be overlooked in light of the severity of the larger cracks, as the amount and degree of cracking present in the plasterwork is being obscured by paint. It is only with large scale removal of paint that a completely accurate documentation of the condition of

the plasterwork can be obtained.⁶⁸ For the plasterwork in room 205, two cracks at the east end of the ceiling exhibit signs of movement. One of the two cracks is in the raised border, the other is in the middle of the vase. The crack which runs along the east side of the central medallion was unlike other cracks from either ceiling because when paint was removed, the plaster underneath was fragmented and had missing material. All three of these cracks had debris fall out when paint was removed to inspect the cracking.

No official record of the condition of the plasterwork has ever been kept; no documentation of the progression of the deterioration is available that can be compared with the current condition, and no documentation of repainting, maintenance or any of the repairs that are visible has been recorded. Martin Jay Rosenblum and Associates have a few photographs from 1990 and 1992 from the period of time during the writing of the Historic Structures Report. These photographs were taken prior to the last repainting of the ceiling and clearly reveal some progressive deterioration.⁶⁹ First of all, the photographs from both 1990 and 1992 show that there was much more staining in the northeast corner than is now visible. This means that the staining visible now has been a chronic problem and one still active at least since the last repainting.⁷⁰ The same 1990 photograph that shows the staining also indicates that the cracks which now converge on

⁶⁸The center field of the ceiling which is currently painted with a tromp l'oeil sky is another case in point. With the exception of one place along the summer beam, currently there are only a few smaller cracks visible in this part of the ceiling. This is not consistent with the amount of cracking exhibited in the other parts of the ceiling, and thus its true condition underneath the painting is suspect, especially considering that parts of the design were painted on top of a fibrous layer adhered to the plaster.

⁶⁹It is evident that the ceiling has been repainted since these photographs were taken because the numerous sample craters from Frank Welsh's 1990 paint study visible in the photographs are no longer visible.

⁷⁰I have repeatedly returned to the area above this staining in the hopes of finding some clue to the cause of it. As of yet I have not been able to pin point any source of water penetration here. The radiator below the north window in room 201 and its accompanying pipes is an obvious source, but there is no evidence of any leaking in the immediate vicinity to it. There are also some water stains on the joists that should not be ruled out, but they are not limited to the area above the staining, and have more of a floor washing pattern to them.

the section of plaster removed to insert scaffolding to support the fireplace trimmer were there before the removal of the plaster and are not a result of the intervention.

In short, with the exception of the large crack on the south side of the west cartouche, many of the cracks recorded in the survey can be seen in nearly the same condition in the photographs from the early 1990s as they are today. There are of course limitations to any conditions assessment done from photographs that have no scale included in the image, but comparatively, the progressive deterioration visible in the photographs from 1990, 1992 and today, of the crack on the west cartouche is substantially greater than in any other recorded cracks (Figures 35, 36). A second source of photographs of the plasterwork is Philip Wallace's *Colonial Houses of Philadelphia* from 1931.⁷¹ In one of his photographs, the crack on the south side of the east cartouche can be seen, though significantly smaller than it is today. A second photograph shows the west cartouche without a crack on its south side, but with a noticeable bulge or crack extending east through the empty central field. This section of plaster, which runs along the large deflected summer beam, was replaced in 1986 with new plaster and expanded metal lath as part of the "facelift" Belmont received for the Junior League's designer showcase.⁷² At this point, further discussion and diagnosis of the condition of the plasterwork cannot be made without first considering the condition of its framing, lath and plaster key support.

⁷¹It is interesting to note the clarity and depth of relief that can be seen in these photographs of the ornament. The image of the west cartouche also shows the bottom of the ornament which is now obscured by coarse repairs to fill the void caused by the dropping cornice.

⁷²The section of plaster that was removed for the west scaffolding support of the summer beam includes a piece of original plaster adhered to the replacement plaster. A cross section view of where the old and new plasters meet shows that the finish coat of the new plaster was built up to the level of the top paint layer on the old plaster and that the painted clouds are the first paint layer on the new plaster. This proves that the replacement plaster and painted clouds were installed at the same time. An article in the *Philadelphia Inquirer* from April 18, 1986 about the Junior League's designer showcase says the following, "Design Accents by Wood and Renkert have turned the living room, with its elaborate stuccoed ceiling, into a pink bower with painted clouds overhead." (Janet Anderson, "Sprucing up a down-and-out mansion," *Inquirer*, Features Weekend, April 18, 1986, pg E03.)

6.2.2 LATH AND PLASTER KEY CONDITIONS

Unlike the plaster surface and structural framing surveys that employed the Drayton Hall study as a model, the lath and plaster keys survey had no direct model to follow. The Drayton Hall study did not conduct this type of lath and plaster key survey because its lath, like many other ornamental plaster ceilings, had been covered over by a recent repair system attempting to re-establish the lath and plaster connection. The literature on the maintenance and repair of historic and ornamental plasterwork generally explains the necessity of examining the condition of the ceiling from above as well as from below. Stressed is the importance of vacuuming the debris to expose the lath and plaster, and of inspecting the plaster for broken keys and loose lath. The types of information that can be gained from the lath and plaster key survey are critical: how many keys are supporting the ceiling and where is the ceiling not being adequately supported. The only way to determine this information from the survey was to identify weak areas and quantify the percentage of broken, missing or inadequate plaster keys.

The procedure established for the survey was as follows: rooms 201 and 202 were divided into a total of six, three foot wide sections, like rows on a chart, with the joists delineating the columns. The number of plaster keys in each resulting cell were counted and recorded on the framing plan, and the broken, missing or inadequate keys of that cell were then drawn on the plan. The criteria for deciding which keys were recorded was simply if they were contributing to the support of the ceiling or not. Recording the broken and missing keys was straight forward, either the key wiggled when it was gently tested or it had broken off at an earlier date and was missing. The judgement of which keys were inadequate as built was more subjective. The literature generally notes that because hand split lath results in variable width spaces, there often is not enough space left for sufficient plaster to squeeze through for a strong key, resulting in original

deficiencies in the support of the plasterwork. This proved to be the case in a number of instances.

The plaster key deterioration was quantified by dividing the total number of recorded broken, missing or inadequate keys by the total number of recorded keys to find the percent of the plaster keys not contributing to the support of the ceiling. With these calculations, 37% of the keys were found to be broken, missing or inadequate. A few cells had greater than 60% inadequate keys. These have been classified as areas of detachment and include three small cells within the fireplace header framing, the area surrounding the west fireplace trimmer where plaster has been removed for the scaffolding, and the area at the east end of the room, adjacent to the summer beam and partition wall between room 201 and 204. Overall, there was no distinct pattern of inadequate plaster keys that emerged from the survey. The majority of room 204 was not included in the calculations for the percentage of inadequate keys because most of the plaster in this room is completely detached from the floor joists. Including this area in the calculations for the rest of the ceiling would not provide an accurate portrayal of what is actually holding up the greater part of the ceiling which is still attached.

There are two areas where the original plaster keys have been replaced with new plaster. The first area is in the northwest corner of room 201. Ten rows of keys are visibly different than the original plaster in color, texture and hardness. These keys are utilizing the original lath and intermingle with the original sound plaster keys at the boundaries of the two plasters. No evidence of the intervention is apparent from the plaster surface below in the form of an interruption of the relief ornament, except for a crack in the area of the replacement plaster. These replacement keys may be a very early repair. The second area of replacement plaster runs along the north side of the summer beam from J5 to J11. This plaster has the honeycomb appearance of plaster that has been pushed through expanded metal lath. There is a range of four to eight rows of this replacement plaster visible on the north side of the summer beam. It appears to extend

across the underside of the summer beam as it can just barely be seen from the south side of the beam between J8 and J9. The plaster removed for the scaffolding that supports the summer beam at J6 has expanded metal lath and a homogeneous dense plaster, while the plaster removed under the beam at J11 has hand-split lath, wrought nails and original plaster.

As mentioned earlier, the majority of the plaster in room 204 is completely detached from the floor joists. The way the plaster is detached, however, is very different on the north side of the summer beam than on the south side. On the south side, the lath and plaster detached as a cohesive unit; the plaster is completely attached to the lath and the lath to the nailers of the joists, but the nailers are no longer attached to the joists. At its lowest point, the plaster on the south side of the beam is 4 1/2 inches lower than the framing. In contrast, on the north side of the summer beam many of the lath are still attached to joists, but the plaster is detached from them, while those lath that are no longer attached to the joists are still attached to the plaster. At its lowest point, the plaster on the north side of the beam is 5 to 6 inches below the joists. The large crack on the south side of the west cartouche is visible from above, and is 4 1/2 inches below joist number two. On both sides of the summer beam, where the lath and nailers are detached from the framing members, the nails are still intact in the wooden strips. The 3/4 to 1 1/4 inch exposed wrought nails show no signs of corrosion or breakage, they have simply been pulled out of the joists and summer beam. There is an even accumulation and distribution of debris on the detached plaster and lath.

Expanded metal lath can be seen extending past the western edge of the plaster along the north half of the ceiling. In three places along the metal lath, wire has been looped over the ends of a one or two lath (Figure 37). These wooden lath are detached from the joists, and there is significant tension on the wires. The wires are connected to the metal lath below the level of the original plaster. It is not possible to tell exactly what the metal lath is attached to, but there are three layers of it, the top and bottom are empty

and the middle layer has plaster pushed through it. The only thing the metal lath could be connected to below the plaster that would not allow it to be seen from the floor is the back side of the wooden cornice. Installation of the metal lath on the back side of the wooden cornice would entail at least partially separating it from the wall. A diagonal cut in the cornice near the northwest corner is currently visible, and is visible in a photograph from 1992 as well (Figure 38).

6.2.3 FRAMING AND STRUCTURAL MEMBERS CONDITIONS

The consequences of plasterwork being one component of a planar system that is attached to the structural members of a building, are that any movement of those members will be directly transferred to the plaster. The condition of the structural system is thus an important factor in determining the causes of deterioration in plaster ceilings. Accordingly, the inspection and documentation of the condition of structural members and of all signs of movement involving them are as important in understanding the presence of cracking in the plasterwork as recording inadequate lath and plaster keys. Non-structural elements such as baseboards and cornices are also important to consider as they, like the plasterwork, are attached to structural members and thus reflect structural movement, past and present.

A visual inspection and survey of the structural members and architectural details was undertaken starting with those members closest to the plasterwork, the joists and summer beam. Like the surveys of the plaster surface and lath and plaster keys, this survey was taken to determine the type, extent and degree of distress or damage visible in the structural members.⁷³ In room 202, J8 through J14 all have cracks of varying width

⁷³J.S.F. Jack's "Notes on the Repair and Preservation of Decorated Plaster Ceilings" gives the best checklist of what to look for when surveying beams and joists. He advises examination for sap-wood, dry rot, cracks and deep fissures, mortises, tenons, knot holes and inaccessible parts of timbers, especially where they enter the walls. Note should be taken of cracks that run from mortise to mortise, decay of lower parts of mortises and tenons, shakes level with the underneath surfaces of tenons and tenoned joists that have pulled out from the beam.

and length, with J9 having cracks on both sides. J8 is warped and J9 through J11 and J14 have cracked tenons.⁷⁴ J2 on the south side of the summer beam in room 204 is cracked and withdrawing from the beam, J3 is warped and withdrawing from the beam, and the tenon of J2 on the north side of the beam is also withdrawing from the beam.

In room 201, attempts to ameliorate the effects of the sagging summer beam on the floor joists are evident from bolted metal strap supports that have been inserted below all the tenons (Figure 39). All the joists also have wooden wedge-shaped pieces on top to level the floorboards. These levelers range in height from 1 1/2 inches to 4 1/2 inches, with every other one bolted to the joists with the same metal straps used to support the joist tenons. The metal straps appear to be an early twentieth century intervention, and could be from the 1926 restoration of the building overseen by Fiske Kimball, the Director of the Philadelphia Museum of Art, who restored a number of the park houses.⁷⁵ There are only two joists with shakes in them from room 201. J8 is cracked on the east side of its entire length, including both tenons (Figure 40). It is also warped, tenoned into a cracked section of the fireplace header and pulling out of the summer beam on the other end. Joist number eleven, the east fireplace trimmer, also has a long shake, is warped and its tenon is pulling out of the summer beam. In addition to these two joists, J5, J9, J10 and J12 through J15 are all partially withdrawn from the summer beam.

The floor joists that support the ceiling of room 101 are 2 1/4" by 9" and are 17" to 22" apart on center. The deflected summer beam is fourteen inches wide, nine inches high and twenty-four feet long. This framing is standard for the eighteenth century and does not reflect any attempts to reinforce the structure to support the extra weight of the

⁷⁴An interesting discovery was that J12 and J13 have a WP (William Peters) inscribed on the west side of them near the summer beam, and J12 in room 201 has the same initials inscribed upside down on the east side of it near the summer beam.

⁷⁵Fiske Kimball, "Belmont Fairmount Park," *The Pennsylvania Museum Bulletin*, 1927, p. 333. Wallace's photograph from his 1931 book shows deformation in the ceiling along the summer beam, so it had deflected by that time, which would necessitate floor levelers in room 201.

plaster ceiling. If anything, the height of the summer beam is undersized for its span and load. The summer beam is set in the masonry exterior walls on either end and has a stud partition wall on top of it. There is a king post truss within the partition wall with diagonals that run to the east exterior wall and to the west partition wall between rooms 201 and 204. The king post is placed at the center of the span of the summer beam, on the southern edge, and has a bolted dovetail detail that can be seen between joists eight and nine in room 202 (Figure 41). From room 201 it is possible to see that the king post and the eastern and western diagonals did not go down with the summer beam as they are all partially pulled out of the beam (Figures 42, 43). The dovetail detail of the king post is also partially pulled up, and it is split up the middle between the bolts. Furthermore, there is an alarming bulge in the partition wall that follows the western diagonal of the truss. In 1986 a truss was installed according to the designs of the engineering firm of C.N. Timbie to convert the summer beam to a multiple span condition in order to increase the live load capacity of room 201 to accommodate the attendees of the Junior League's designer showcase. A C15 x 33.9 steel channel was placed beneath the third floor framing spanning north-south, a pair of hanger rods extends down from it and picks up the summer beam approximately six feet from the west end, and the east wall of room 204 was built out to enclose this steel reinforcement.

On the first floor, the wooden cornice is separating from the ceiling in room 101 on all four sides. The cornice in room 205 is likewise at least partially separating on all four sides from the ceiling. The cornice on the west wall of room 101, like the plaster above it, is almost completely detached and is sagging substantially in the middle. In a photograph from 1989 this cornice is visibly sagging above the door. A photograph from 1992 also shows a large open crack where it has separated from the ceiling along the north end (Figure 44). The cornice has continued to drop since 1993 when the room was repainted to its current deep red color. This is evident as the red painted wall can be seen from room 204 above the current level of the cornice. The south wall of room 101 is also

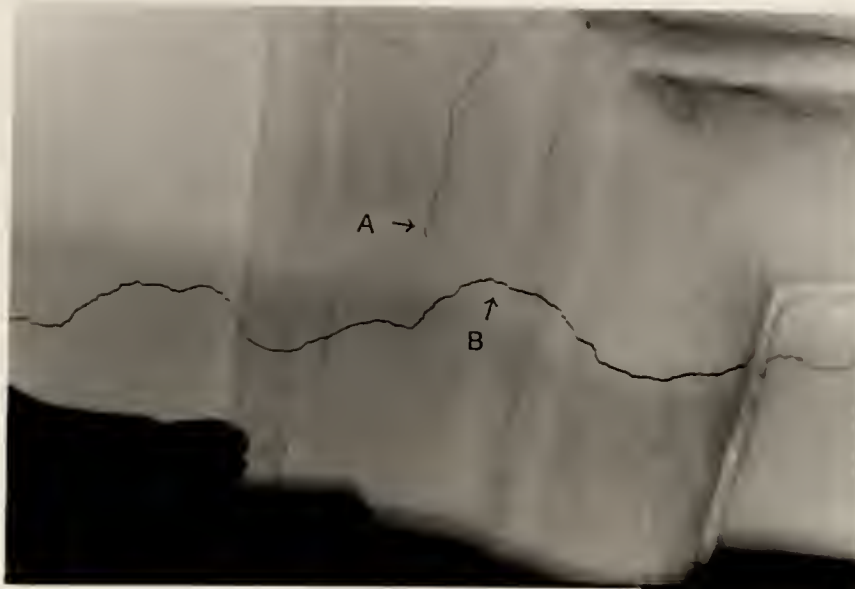
exhibiting signs of movement in the form of canted door heads, separating cornice and a buckled baseboard. In 1986 steel shoring was installed in the basement under the south wall of room 101. This wall is possibly being affected by the second floor framing. The unequal span of the joists on the north and south side of the summer beam may result in eccentric loading on the south side where the joists are carrying greater load with shorter span because the south wall of room 101 intersects them only 6 1/2 feet to the south of the beam. Deflection in the summer beam would also increase the load bearing down on the first floor south wall. This combination of eccentric loading and deflection may be the reason why more joists on the south side of the summer beam are exhibiting distress in the form of long horizontal cracks than on the north side of the beam. Like the sagging cornice on the west wall, the movement in the south wall was an existing condition at the time of the last repainting, and has been an active one since then. The evidence for this is that the baseboard was buckled at the time it was last repainted, and it has buckled more since then (Figure 45).

Figure 29 Illustrated Glossary Of Conditions

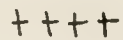
Cracking



Fractures of variable length, width and orientation
 Small - horizontal displacement ≤ 0.30 mm, generally accompanied by cracked plaster underneath. (A)
 Large - horizontal displacement ≥ 0.40 mm(B)



Vertical Displacement



Settlement of one side of a crack relative to the other side - resulting in planar discontinuities.



Illustrated Glossary Of Conditions

Patching



Subsequent infill, replacement keys and surface repairs made to the original plaster.



Plaster Loss



Absence of one or both layers of rough and finish coats of plaster.



Illustrated Glossary Of Conditions

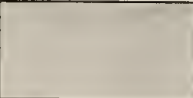
Staining



Discoloration from water damage or by deposition of minute deposits of matter within the pores of the painted plaster.



Paint Failure

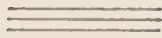


Large scale map cracking observed on painted ceiling relief elements of room 205.

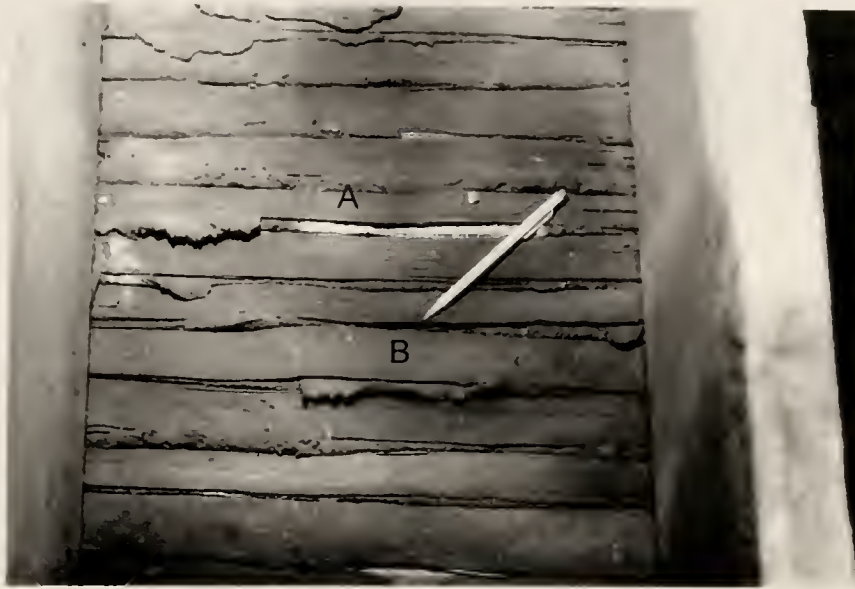


Illustrated Glossary Of Conditions

Plaster Key Failure



Keys partially or completely broken in place, missing (A), or inadequate as built (B).



Detachment



Separation between the lath and plaster or plaster and floor joists. (Note: no detachment observed between plaster layers).

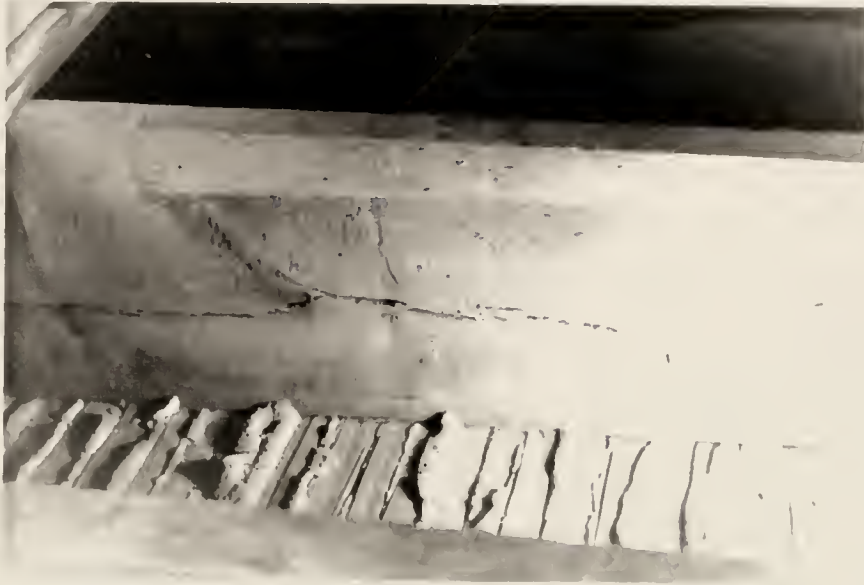


Illustrated Glossary Of Conditions

Cracked joist



Long horizontal fracture visible along one or both sides of the joist.



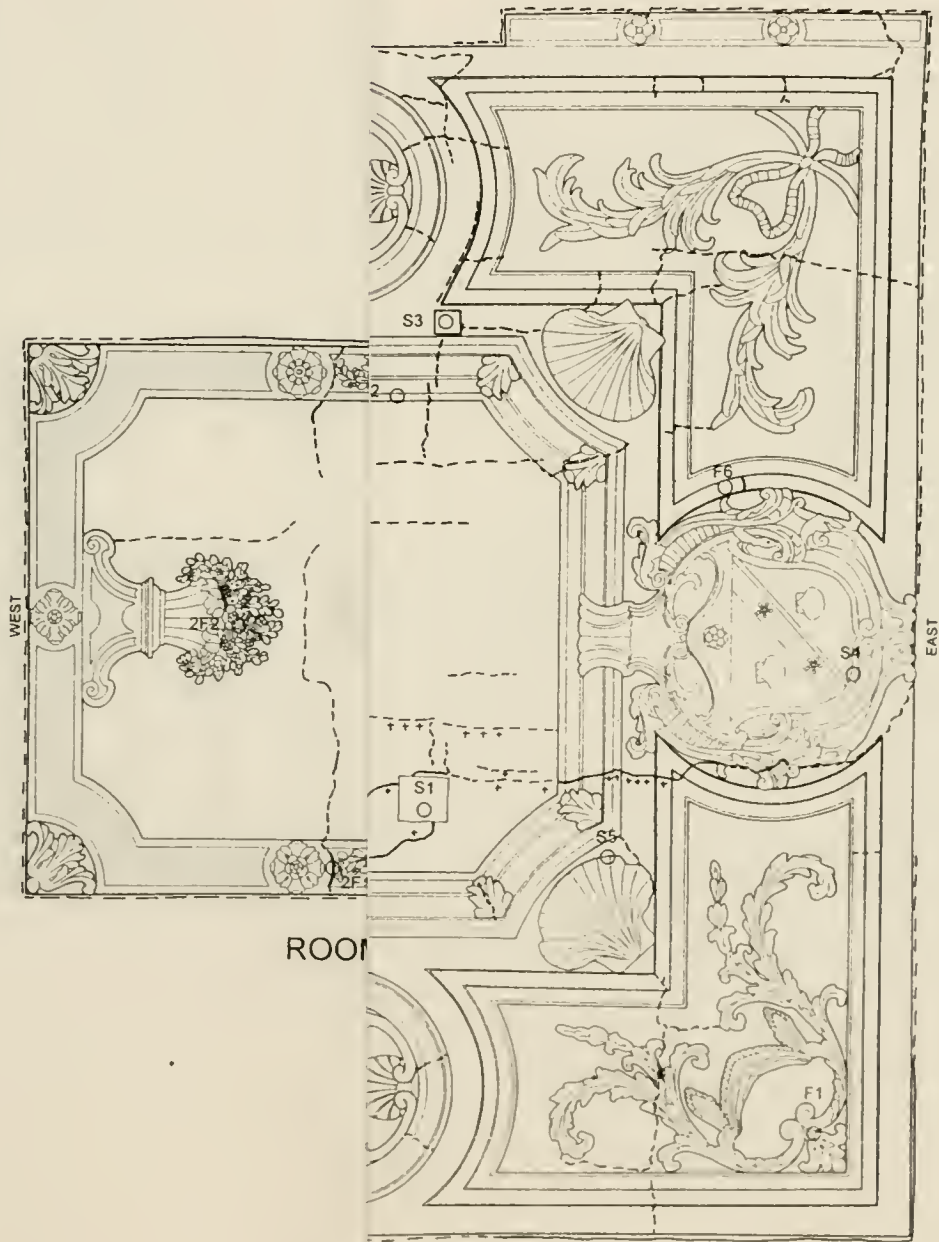
Withdrawn Tenon



Joist tenon that is pulling out of its mortise in the supporting summer beam.



Figure 30

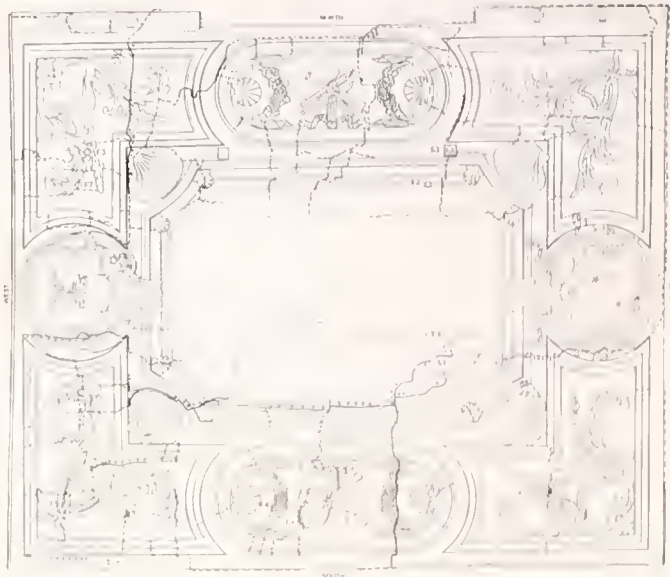


Sample Locations
 Plaster Samples
 Paint Samples

Figure 30



ROOM 205 CEILING PLAN



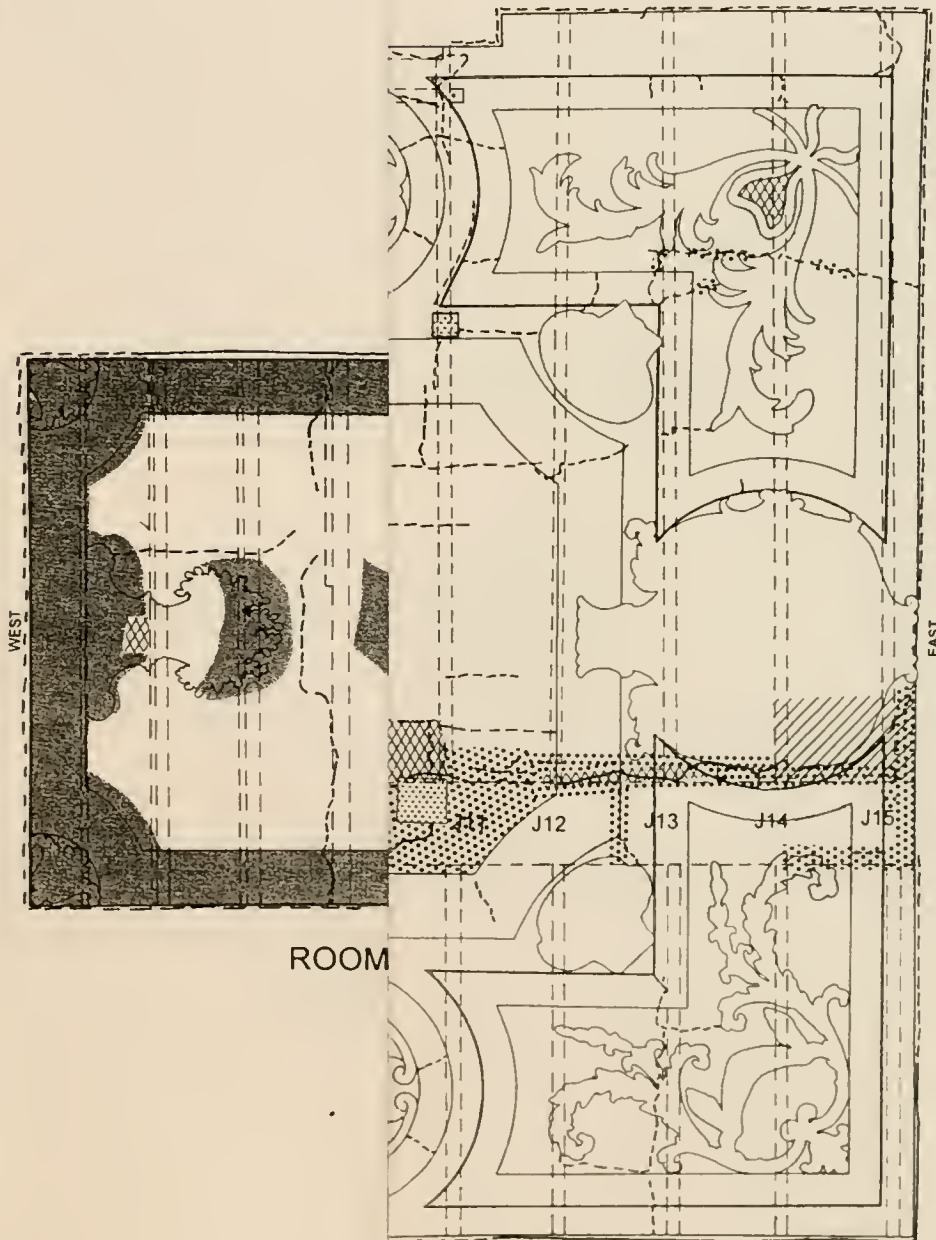
ROOM 101 CEILING PLAN

CONDITIONS SURVEY

DRAWING 1 LEGEND)

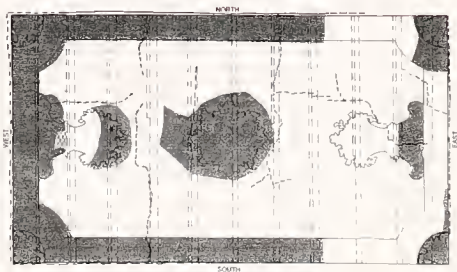
- Narrow Cracks - 0.30 mm
 --- Wide Cracks - 0.40 mm
 + + + Vertical Displacement
- O Sample Locations
 S1 Study Samples
 F1 Other Paint Samples

Figure 31



achment
hing
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er Loss
t Failure

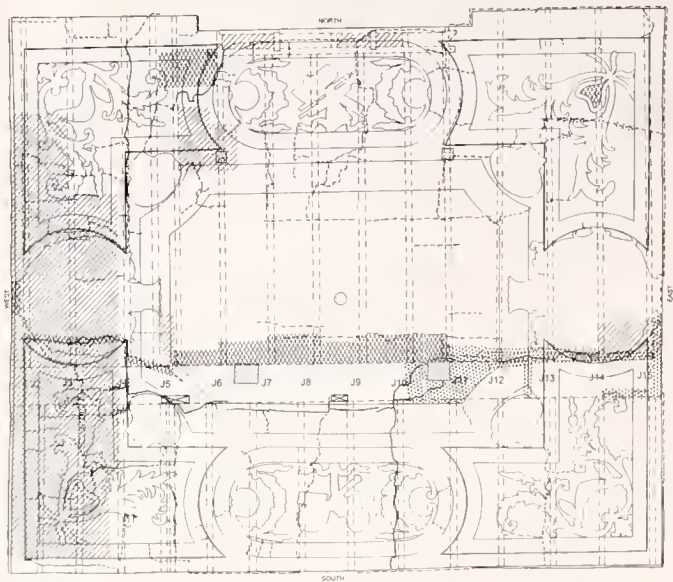
Figure 31



ROOM 205 CEILING PLAN

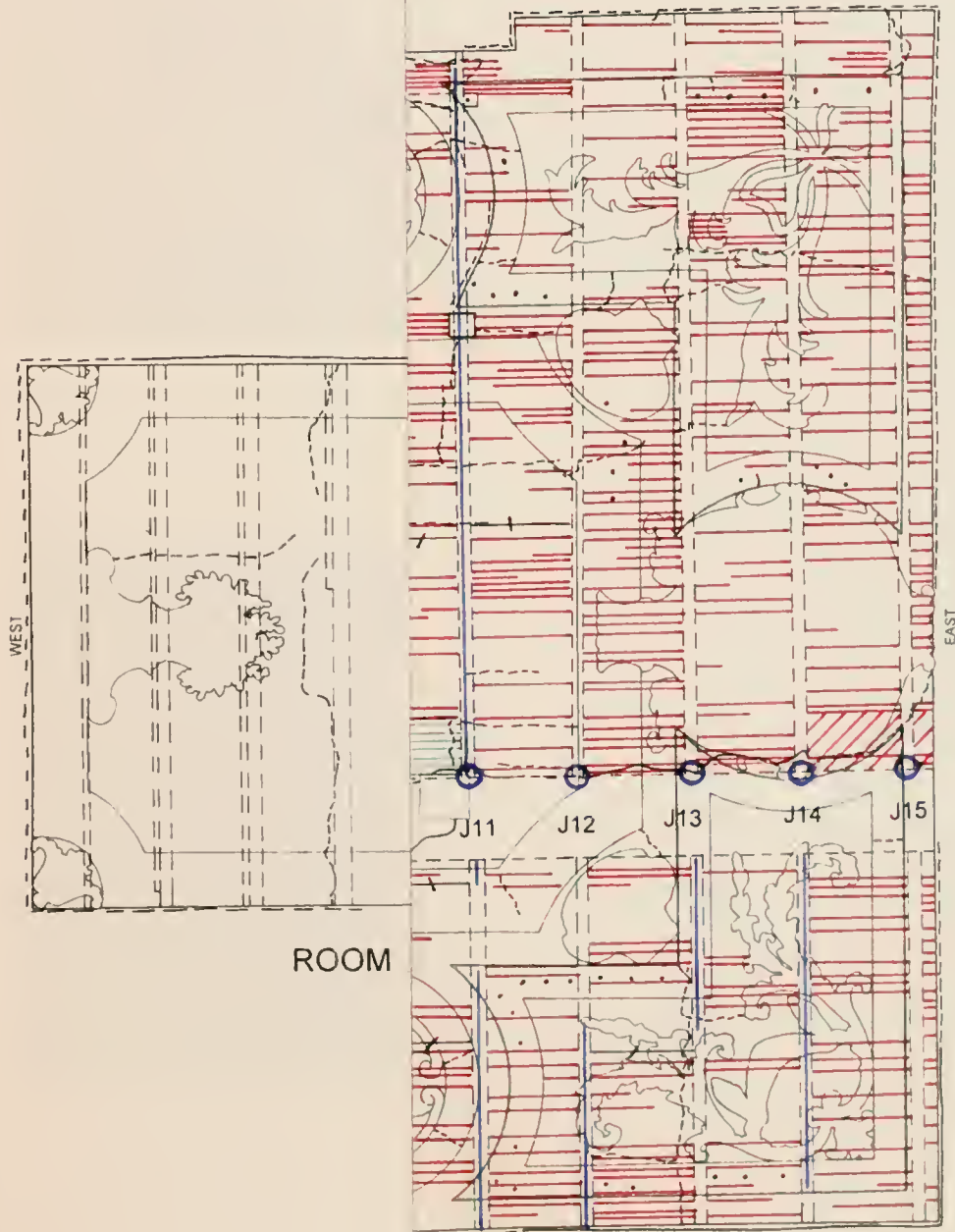


CONDITIONS SURVEY DRAWING 2 LEGEND	
----- 2 nd Floor Framing System	Detachment
----- Narrow Cracks ≤ 0.30 mm	Patching
----- Wide Cracks ≥ 0.40 mm	Staining
	Plaster Loss
	Pain Failure



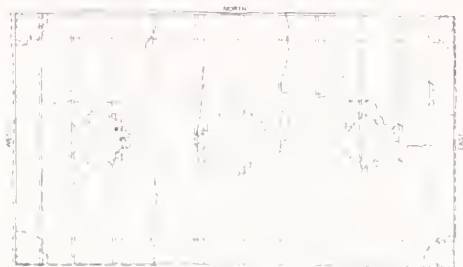
ROOM 101 CEILING PLAN

Figure 32



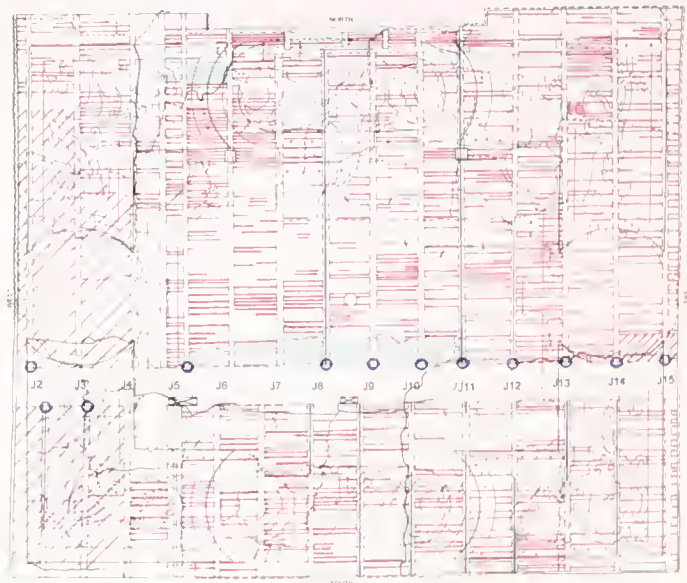
ed Joist
awn Tenon
edges
ps
ath

Figure 32



ROOM 205 CEILING PLAN

CONDITIONS SURVEY DRAWING 3 LEGEND	
--- 2 nd Floor Framing System	○ Cracked Joist
- - - Narrow Cracks ≤ 0.30 mm	○ Withdrawn Tenon
— Wide Cracks ≥ 0.40 mm	— Lath Wedges
— Inadequate Plaster Keys	— Nail Tips
— Patching	— Metal Lath
/// Detachment	



ROOM 101 CEILING PLAN

Figure 33 Detail of uneven surface due to overpaint on plaster.



Figure 34 Detail of patched crack on south side of east cartouche.



Figure 35 West Cartouche in 1990.
From Martin Jay Rosenblum, R.A. and Associates.



Figure 36 Detail of crack on south side of west cartouche in 1996.

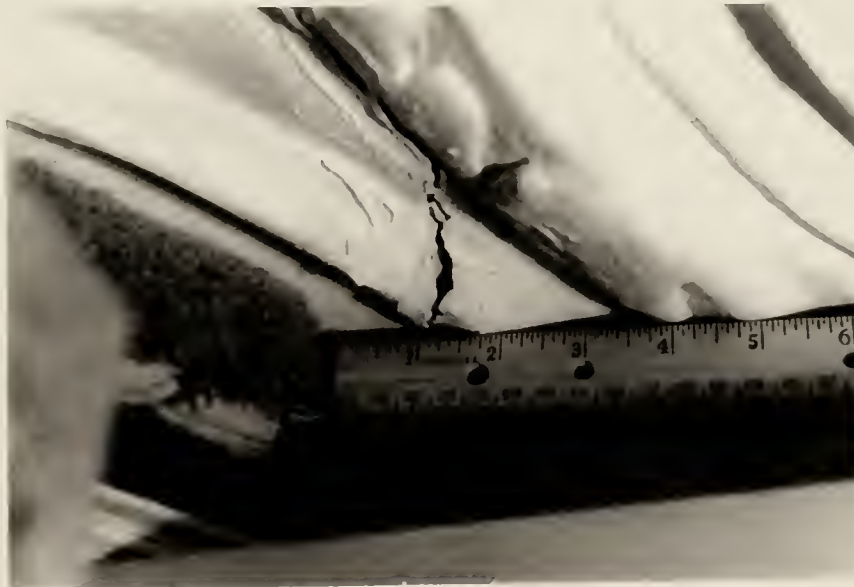


Figure 37 Detail of wire looped over lath in room 204.



Figure 38 Detail of cut in room 101 west cornice.
From Martin Jay Rosenblum, R.A. and Associates, 1992.



Figure 39 Detail of Metal strap tenon support and floorboard leveler with metal strap.



Figure 40 Detail of Joist 8.

J8 is cracked and tenoned into a cracked section of the fireplace header in room 201.



Figure 41 Detail of split dove-tail joint of king post truss.



Figure 42 Detail of king post partially pulled out of summer beam.



Figure 43 Detail of western diagonal of truss partially pulled out of summer beam.



Figure 44 Room 101 west wall cornice separation from ceiling in 1992.
From Martin Jay Rosenblum, R.A. and Associates.



Figure 45 Detail of room 101 south wall buckled baseboard.



6.3 DETERIORATION EVALUATION AND DIAGNOSIS

The recognized approach to diagnosis in architectural conservation is to establish the relationship between past and existing conditions, symptoms, and mechanisms of deterioration. In the previous section, the conditions surveys identified the amount, degree and type of deterioration present in the plasterwork, lath and plaster key system and structural members. In this section, an evaluation of the conditions survey results in relation to intrinsic and extrinsic factors will be analyzed to identify the possible causes of structural deterioration currently exhibited in the plasterwork. Intrinsic factors that potentially affect the structural condition of the plasterwork include the original materials, design, technology, and installation of the ceilings, as well as subsequent maintenance and repairs to which the plasterwork has been subjected. The extrinsic factors which may affect the integrity of the plasterwork include the structural condition of the building, interventions to the building's structure and environmental factors.

As cracking, staining, detachment and previous repairs are four major symptoms of possible structural distress and deterioration in plasterwork, identifying the causes of these specific conditions exhibited in the plasterwork will be the focus of this evaluation. With regard to intrinsic factors, there are no inherent defects in the material itself as the plaster generally appears to be very strong and durable, even at large cracks. There is no separation between the layers or loss of cohesion within the material and no detachment of ornamental elements from the flat plaster. Roughly 37% of the plaster keys are broken or inadequate as built. This may constitute a defect in the material or in the installation of the ceiling, as insufficient space left between the lath accounts for almost all of the inadequate plaster keys. There are a number of cracks that coincide with instances of detachment and previous repairs. Moving clockwise around the ceiling, the large crack that occurs below the fireplace header framing is in an area where greater than 60% of the keys are broken and thus this area is considered detached. The long east/west crack on

the north side of the summer beam in the center section of the ceiling runs along about half of the boundary for the replacement plaster at the beam. In the southwest corner of the ceiling along the south wall there is a large crack with significant vertical displacement on the north side. This crack is at the boundary of detachment in room 204, the plaster and lath on the north side of the crack are detached from the floor joists, while the plaster and lath on the south side of the crack are still attached to joists. Finally, in the northwest corner of room 201, there is an area that has replacement plaster keys between the partition wall and west fireplace trimmer. The plaster underneath this area has a large crack that roughly follows the boundary of this repair.

There is significant distress and deterioration evident in the plasterwork due to all three extrinsic factors, the structural condition of the building, interventions to the building's structure and environmental factors. As with the intrinsic factors, cracking, detachment and repairs are the major conditions of deterioration exhibited in the plasterwork, however, staining is an additional condition associated with environmental factors. Deterioration due to the structural condition of the building can be seen with the number of cracks that correlate to framing members. Considering that any movement of the framing members will be transferred in some degree to the plaster attached to it, and that cracks will develop along lines of compression, (perpendicular to lines of tension), the presence of cracks below joists and the summer beam is indicative of some structural movement. Summarizing these cracks, on the south side of the summer beam, four run along joists (J5, J8, J10 and J14) and one along the beam in the vicinity of the king post and western diagonal of the truss in the partition wall. On the north side of the summer beam, again four run along joists (J4, J7, J9 and J11) and one along the beam starting at the east cartouche and extending to the east fireplace trimmer, then running across the beam and continuing south along J10. Four of the above mentioned cracks run along joists that are cracked and five are located within the middle span of the ceiling.

The movement of the joists can be attributed at least in part to the deflection of the summer beam, a condition which apparently has been long-standing and has had widespread effects throughout the entire building. A survey completed by Keast and Hood Co., structural engineers, in July of 1991 for the Historic Structures Report concluded that the south wall of room 201, which is located on top of the summer beam, operates as a load bearing wall receiving load from the attic, third floor and roof through the third floor joists. In its current condition and with tenons partially withdrawn it was also concluded that room 201 has virtually no live load capacity. Looking at the dovetail detail and king post and diagonals connections, it seems likely the truss was not part of the original construction of the building but rather was a later addition attempting to compensate for extra load on the partition wall that would contribute to the deflection of the beam. One possibility is that the truss was installed when the third floor was added in the mid-nineteenth century because deflection was noted in the beam at that time and it was realized the third floor addition would be adding even more load to the bearing wall on the beam. If this was the case, then it may explain why the king post and diagonals have all pulled out of the beam as it continued to deflect instead of going down with the beam as would be expected to happen with an original construction detail. Additional questions regarding the current condition of the partition wall include: what does the bulge on the north side of the partition wall in line with the western diagonal mean in relation to the wall being load bearing, continued deflection of the summer beam and potential structural failure of the wall?

The significant deflection of the summer beam has been cited as the cause of the large scale detachment of the plasterwork from the floor joists in room 204.⁷⁶ Why then,

⁷⁶C.N. Timbie, Structural Conditions Notes, July 24, 1995. 1.3 "Original center summer beam was braced with a light timber truss built within the partition above. The truss has failed and summer beam is sagging about 6 inches. Sag has caused the thick plaster ceiling to peel away from the joists at the west end (under hallway)."

is the large scale detachment localized at the west end of the ceiling and not in the middle where the greatest deflection is? Why is the manner of detachment so different on the north side of the summer beam where some of the lath are still attached to the joists and some to the fallen plaster, than on the south side where the entire system of plaster, lath and nailers all detached from the joists in one intact, complete unit? Is the cornice on the west wall suspended from the wires that are looped over the detached lath with significant tension, and what effect has this added weight had on the sagging plaster and the manner in which the plaster on that side of the beam has detached from the joists? It is obvious from the above conditions that the west end of the ceiling has been subjected to some significant trauma the rest of the ceiling has not.

It has been pointed out that lath and plaster ceilings are particularly vulnerable to damage from vibration.⁷⁷ Sources of vibration from the second floor that would effect the ceiling include foot traffic through the house, and interventions. Removing and resetting floorboards is one such intervention. The floorboards in room 201 are the original random width boards, which are known to have been taken up and reset at least once in the history of the building for the installation of the levelers and tenon supports. In rooms 204 and 205, however, the floorboards are modern narrow hardwood boards, 2" wide by 3/4" thick.⁷⁸ There are a number of other variables that are different for the west end of the ceiling than for the rest of it. The most obvious variable is that the traffic pattern for the second floor has been concentrated in room 204, the hallway, for the entire life of the building. Access from both stairways to all three rooms on the second floor is through room 204. A major early intervention was the construction of the stairtower on the west wall. Apparently the entire west wall had bulged out at the center before the

⁷⁷Bernard Fielden, *Conservation of Historic Buildings*, (London: Butterworth and Co., 1982) 313.

⁷⁸HSR 2-16.

construction of the stairtower.⁷⁹ These two factors could have worked together over the course of 200 years to significantly weaken the attachment of the plaster ceiling to the framing system. Work from 1986, with the installation of the steel channel running north/south along the hall, the attachment of the hanger rods to the summer beam and the building out of the hall wall to cover the truss, is another known intervention which would produce significant vibration. This intervention, followed by the Designer Showcase event, could easily have resulted in the detachment of the already weakened plasterwork from the joists and beam. The ceiling could then have slowly continued to drop over the next ten years, pulled down by its own weight, vibrations from pedestrian traffic, and possibly the extra weight of the north half of the cornice suspended from it.

The extensive water damage to the east end of the plasterwork as a result of the broken radiator is obviously an environmental extrinsic factor in the deterioration of the ceiling. It has also become an intrinsic factor however, because the water saturation has damaged the material, possibly reducing its strength and cohesion. This is evident in the development of newly visible cracks since the conditions survey was taken in October, and the enlargement and connection of existing cracks that have accompanied the staining. Some amount of water infiltration is still continuing to occur, however, as the appearance of new water stains on the cornice and ceiling after a recent driving rainstorm indicates. The vulnerability of both ceilings to water damage is in fact currently very high due to unsecured windows in rooms 201 and 307. This vulnerability is only increased by the removal of the floorboards, and for room 101, the removal of the piazza ceiling which has exposed exterior masonry that has holes and missing mortar.

⁷⁹HSR 2-22, however, the HSR does not identify the evidence used to make this statement.

7. FURTHER INVESTIGATIONS

Understanding that the first step towards diagnosis and treatment of any material is the conditions survey, the goal of this work on the ornamental plaster ceilings of rooms 101 and 205 was to record the amount, degree and type of failure present in the ceilings, to identify the possible causes of deterioration, and to establish a base record of the conditions that could be used for future monitoring to track the rate of change over time of the identified conditions. Through the process and findings of the conditions survey, a greater understanding of the materials and systems has been gained. With this knowledge, areas for further investigation can be identified and an evaluation of treatment options can begin. In this final section, some areas for further investigation have been recommended as well as some general recommendations, and a preliminary investigation of treatment options has been started with an initial survey of conservation literature published on plaster consolidation and reattachment, and paint removal.

7.1 RECOMMENDATIONS

Listed below are some general recommendations and recommendations for further investigation based on the findings of the conditions survey and deterioration analysis.

- Installation of crack monitoring devices as soon as possible, especially prior to the beginning of construction on the building to determine if crack movement is cyclical or progressive.
- Continued restricted access to rooms 201, 202 and 204, remaining aware of the affect the deflection of framing members and vibrations have on the plasterwork.
- Completion of a comprehensive investigation of the structural condition of the building and how it directly affects the plaster ceiling in room 101, including: the condition,

deflection and load capacity of the individual framing members, and load paths, especially looking at the south walls of rooms 201 and 101.

- Address the water conduction system: where is rain water infiltrating the masonry walls, unsecured windows, piazza roof, and exposed masonry on the east wall.

- Investigate the room 101 west wall cornice where it is suspected to be suspended from the ceiling lath above to determine the impact of that extra weight on the ceiling.

- Complete the survey of the framing members and plaster key conditions for the room 205 ceiling.

- Further analysis of the paint binders and composition to establish a record of the history of finishes applied to the ceilings.

- Following the above study, or in conjunction with it, removal of paint to confirm the extent and severity of the cracking in the plaster.

7.2 TREATMENT OPTIONS

The following is a brief summary of selected published literature and a list of citations on the subjects of plaster consolidation and reattachment and paint removal from plaster. Nonetheless, with the exception of emergency measures, no plaster treatments should be undertaken until the structural problems which are causing the failure in the plasterwork have been addressed. Once this has been done, a treatment testing program based on options provided in the literature below should be designed and implemented.

7.2.1 PLASTER CONSOLIDATION AND REATTACHMENT

Morgan Phillips has lead the field in the research and development of methods for the reattachment of plaster to lath with acrylic foam adhesives since the 1970s. The method he has developed and successfully employed over the last twenty years is a viable

and preferable alternative to other more heavy handed treatments that obscure the original lath and plaster keys with an over layer of plaster and mesh.

Fitler, John. "Plaster Imperfect." *Traditional Homes* 7, no. 4 (January 1991): 91-93.

Ladygo, Andrew. "New Techniques for Restoring Decorative Plasterwork." *The Construction Specifier* 41, no. 7 (July 1988): 105-112.

Phillips, Morgan W. "Adhesives for the Reattachment of Loose Plaster." *APT Journal* 12, no. 2 (1980): 37-63.

Phillips, Morgan W. "Experiences in the Use of Acrylic Plaster Adhesives." Case Studies in the Conservation of Stone and Wall Paintings: Preprints of the Contributions to the Bologna Congress, September 21-26 1986. N.S. Brommelle and Perry Smith, eds. London: International Institute for Conservation of Historic and Artistic Works, 1986.

Phillips, Morgan W. "Alkali-Soluble Acrylic Consolidants for Plaster: A Preliminary Investigation." *Studies in Conservation* 32, (1987): 145-152.

Phillips, Morgan W. "Aqueous Acrylic/Epoxy Consolidants." *APT Bulletin* 26, no. 2-3 (1995): 68-75.

7.2.2 PAINT REMOVAL

The citations below encompass two types of literature on paint removal from plaster, removal techniques and information on chemical strippers. The Technical Advice Note by Historic Scotland and the article by Brian Powell discuss the following paint removal techniques for plasterwork.

- Machine abrasion, sanding and blasting are not acceptable methods of paint removal from plaster due to the obvious damage they could cause.
- Heat stripping likewise should not be used because of the fire hazard to the historic building, the risk of lead poisoning and heat dissipation into the plaster which will drive water out of the gypsum crystals.

- Emulsion paints can be broken down using steam and then sponged or lightly scraped off and size-bound distempers can be washed off with hot water and a sponge or brush.
- Chemical stripping is an option for oil-based paints, but caustic preparations should never be used because they leave alkaline salt deposits and may not be fully neutralized causing future plaster deterioration and subsequent finish failure. Solvent-based removers are effective for removal of paints from plaster, but they have to be used carefully because they can be harmful to the applicator's health. Precautions should also always be taken with the removal of the lead based layers.
- Limewashes only need to be removed if they are flaking or failing. This can be done with warm water containing dilute acetic acid. Shellac and glue sizing layers that have decomposed often create a cleavage layer when the stronger oil paints above them shrink. This can greatly aid the removal of the top layers of paint.

The distinct heterogeneous nature of the paint layers on the Belmont ceilings suggests that different methods of removal sequentially applied may offer the best controlled results. Removal of the layers of Groups 2 and 3 down to the layers of Group 1 would effectively remove more than half of the accumulated paint build-up and allow for further study of the condition of the plaster and earlier finishes. A full site testing program of materials and methods of paint removal should be developed and conducted in a representative area of the ceiling as the next phase of research. Finish selection and replication trials should be delayed until the interpretive program of the interior has been finalized.

Center for Preservation Research, Columbia University. "Testing program for PEEL AWAY paint removal SYSTEMS 1 and 2: Summary of Investigations." 1987.

Historic Scotland Technical Advice Note 2. "Conservation of Plasterwork." Edinburgh: Cambreth Allen, 1994.

“Paint Strippers: Methylene chloride hard to beat.” *Chemical and Engineering News* (September 25, 1995): 45-47.

Powell, Brian. “Painting Techniques: Surface Preparation and Application.” *Paint in America*. Washington D.C.: Preservation Press, 1994.

Stagg, William D. and Brian F. Pegg. *Plastering: A Craftsman's Encyclopedia*. New York: Crown Publishers, 1976.

Wollbrink, Thomas. “The Composition of Proprietary Paint Strippers.” *Journal of the American Institute for Conservation* 32 (1993): 43-57.

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APPENDIX A

Peter Nicholson (1765-1844). Practical masonry, bricklaying, and plastering, both plain and ornamental. London: Thomas Kelly, 1847.

Chapter II Of the Materials and Compositions used in Internal Finishing

329. Laths

330. Lime

331. Sand

332. Lime and Hair, or coarse stuff, is prepared in different ways, which must be determined by the quality of the materials.

When prepared from chalk or lime-stone of weak nature, it is screened and prepared in the usual way, similar to common mortar, with the addition of hair from the tan-yard, and may be used a few days after its preparation; but when the lime-stone is of a hot or hard quality, it is not advisable to adopt this method, for if the stuff be used soon after its preparation, it will inevitably cause blisters in the work. The safest mode of preparing lime and hair, when the stone is of a strong nature, is by forming a pan or binn of a convenient size, perfectly water tight, and about 18" in depth. A large tub must then be procured into which the lime, after having been slacked must be put and mixed with a proper proportion of water, run through a sieve with apertures not exceeding 1/4", until the pan is filled, when the hair and sand must be added, the whole being well incorporated with a drag or three-pronged rake. There must then be a small hole made at a suitable height in the side of the pan, to allow water to escape. After thus remaining until it be sufficiently set, it may be taken out of the pan and made fit for use by the labourers.

This composition is used for the first or pricking-up coat, and for the floating of ceilings and walls. It is also used for mouldings and cornices which require much stuff, in which case it is mixed with plaster of Paris.

333. Fine Stuff is commonly used for giving the last coat to the plain surfaces of floated work. It consists of pure lime slacked with a sufficient quantity of water, well saturated. It is afterwards run through a fine sieve, and put into tubs in a semi-fluid state, where it is allowed to settle and the water evaporated, when a small portion of white hair may be added, which will very much improve its quality.

334. Stucco, for inside walls

335. Plasterer's Putty, is prepared from unslacked lime, the process being performed by immersing the lime in water where it remains until it be completely dissolved, the liquid being then strained through a very fine sieve must be left in this state until set, when it is considered fit for use.

Putty is used in all finer branches of plastering, as for setting or last coats of soffits, and for the running of mouldings and cornices. When it is used for mouldings, it is mixed with plaster of Paris, which induces it to set quickly and become more dense.

336. Stucco, which was used by the old ornament-workers, is prepared in a very peculiar manner. It has, since the invention of casting ornaments in moulds, almost entirely fallen into disuse; however, it is but proper here to notice it for the benefit of the curious.

A sufficient quantity of fine putty being procured to complete the portion of work contemplated, some marble-dust, made very fine, or pounded alabaster, (and in some cases very fine silver-sand,) must be added. This mixture must be well chafed and spread over a brick-wall, in order to assist the co-operation of the water. After it becomes stiff, it must be taken from the wall, and well chafed with a wooden beater until it becomes tough; it must then be spread over the wall a second time, and the same process repeated, viz. chafing it well with the beater until it becomes plastic, when it is fit for use, and may be applied to the ornamental work after it has been first boasted with lime and hair.

This kind of stucco is sometimes mixed with a small portion of burnt plaster of Paris, prepared in the manner of lime, instead of being, according to the usual mode, baked in an oven, which prevents it from setting within 24 hours.

Many specimens of ornament worked with this composition by Durham, who was a pupil of Catezi's may be seen in many parts of the north of England.

337. Plaster of Paris, as it is commonly called, is the composition on which the plasterer materially depends for giving the precise form and finish to the decorative part of his work; by its aid he executes all the ornaments applied to ceilings and cornices, besides sometimes mixing it with his lime used in the finishing coat of the walls and ceilings of rooms, in cases of emergency, when time is of material consequence. This composition is known among chemists, by the several names of sulphate of lime, selenite, and gypsum.

Chapter IV Operations in plastering, and Modes of performing them.

346. Lathing, which is the method of preparing walls for the reception of plastering, consists in nailing thin slips of wood, of divers lengths, on ceilings and walls. The nails used in lathing are of two sorts, viz. wrought and cast-iron: the wrought-iron nails are much to be preferred. The cast-iron ones may be employed for common purposes, but cannot be used with any degree of safety, when the joists of the building are composed of oak. For stoothed walls or partitions, the lightest or single laths may be used, but to ceilings, or any description of work requiring strength, double laths ought always to be applied.

After having determined the size of the ceiling, or walls, the laths whose lengths best suit the spaces between the joists must be chosen, and the nailing so managed, that the joists be as much broken as possible, as paying attention to this will strengthen the plastering laid thereon by giving it a firmer key of tie.

347. Pricking-up

349. Two-coat work

350. Floating, is the laying on of the coat of plastering (on all work intended to be well finished) immediately following the pricking-up coat. In floating ceilings the following directions must be observed: -

The pricking-up coat being sufficiently dry, and the projection of the cornice ascertained from the drawings, and marked on the ceiling, a screed must be formed about 8" wide at this projection, perfectly straight and level. This is effected by driving in a nail at the projection of the cornice, allowing it to protrude sufficiently from the pricking-up coat to allow the usual thickness of floating, which is generally about $1/2$ ", a convenient level being then procured, another nail is put in at its extremity and adjusted until it exactly coincides with the first nail. This process being followed up all round the ceiling, other nails are put in directly opposite to those already mentioned, and about seven or eight inches from them, being at right-angles from the walls, and made exactly level with the former ones, by the assistance of a small triangle. A portion of course stuff must then be applied between the nails, and with a short float bearing on the two nails made perfectly straight, which forms what the plasterer terms a dot. These dots are formed at each length of the level, which is commonly 10 or 12 feet. When the dots are sufficiently set, the spaces between them are filled up flush with course stuff, and finished with the floating-rule, which must be about two feet longer than the level, so that it may bear well on each of the dots. This being finished, it forms a perfect screed round the whole of the ceiling, and serves as a guide in the floating of the inner part of the room, which being set, the spaces between them are filled up flush, and made even with the face of the screeds.

The floating is thus finished, by applying the floating-rule on the screeds and moving it backwards and forward until the whole of the floating is completely level with them. The ceiling is then gone over with the hand-float, making good any deficiencies that may appear in the floating, by adding a little soft stuff, until the whole is a perfectly smooth and compact mass.

351. Setting. -After the floating has remained until it be quite firm and solid, which requires it to be nearly half dry, it is covered with a thin coat of putty (mixed with a little fine sand, and sometimes a little white hair,) called setting. In cases of emergency, the putty is gauged in small quantities at a time, by adding to it about $1/3$ of plaster of Paris, which causes it to set more quickly. The floated work must not be allowed to get too dry before the setting is applied to it, otherwise there is a probability of it cracking and eventually peeling off, thus giving the ceiling an unsightly appearance. But cracks in ceilings may arise from the laths being too weak, or from too much plaster being laid on, or from strong laths and too little plastering. Floated work, executed by a judicious workman, the materials being good, and the lathing properly attended to, no fears need be entertained of its cracking without the shrinkage of timbers.

367. Working Ornament by Hand. The forming of ornaments of every description in their proper places, by means of suitable tools, commonly called "Hand Ornament

working," is at the present day but partially practised, having been, in a great measure, superseded by the invention of cast-work; but, notwithstanding, we think it necessary to advert to it. In working ornament, according to the method practised by the old Italian stucco-workers, it is necessary, in the first place, to draw the design of the ornaments, either in the cove or what ever situation they are intended to fill; the foliage, shields, trophies, fruit, flowers, or whatever it may be, must then be boasted, or got out in the rough, with gauged fine stuff, which is afterwards followed up by a thin coat of the kind of stucco, which we have described in our account of materials, under the head of "Ornamental Stucco," which must be worked into the proper shape, and finally finished with the assistance of small steel tools of various sizes and patterns.

When the ornaments are intended to have a great emboss or projection from the ground, long nails, with tarred-twine twisted round them, for the purpose of making the stuff adhere more closely, must be driven into the timbers; and in the formation of festoons of flowers, &c., which are to hang completely clear, it will be necessary to attach copper wire of sufficient length to the plain surface of the work, which must be bent to the particular shape, and placed in positions that will not interfere with the design of the work when viewed from the floor.

The manner of giving the embellishments a boldness proportionate to the height of the rooms in which they are executed, can be attained by practice and shrewd observations alone; but a knowledge of drawing, and a facility in sketching, will be found of great assistance in the acquirement of this department of ornamental plastering.

Enriched moldings in cornices, prior to the invention of cast-work, were also worked in their situations by filling the spaces left them with soft stucco, on which was pressed a reverse leaden mould, which left the impression of the ornament, this impression being afterwards cleaned up with steel tools.

368. Modelling. The whole of the ornaments cast in plaster of Paris are previously modelled in clay, which method, as we have before stated, has of late years almost entirely supplanted the process of working the ornaments in their places by hand. . . .

369. Moulding Ornaments. There are two methods of moulding practised by plasterers, viz. moulding in wax, and moulding in plaster. . . .

370. Moulding in Plaster.

371. Casting in Plaster.

372. Fixing Ornaments. When the enrichments about to be fixed are small in size, they may be fixed in the grooves or indents prepared for them with putty well gauged with plaster; but when the ornaments are of a weighty description, it becomes necessary to use fine stuff, and to cut away the plain surface of the work as far as the lathing. The place, so cut away, is then filled with gauged fine stuff, and the cast being well scratched on the back in the form of a dove tail, must also have a portion of fine stuff laid on it when it is placed in its proper position, and pressed to the work, so that they may both incorporate.

When the ornaments are extremely heavy, such as coats of arms and shields, in addition to the above mode, it is indispensably necessary to have recourse to large screws, which must pass through the cast-work into the timbers.

Chapter VI An Explanation of the Terms, and Description of Tools used in Plastering.

APPENDIX B

Materials Characterization Data.

ARCHITECTURAL CONSERVATION LABORATORY UNIVERSITY OF PENNSYLVANIA

MORTAR ANALYSIS

Project/Site: Belmont Mansion

Location: West Fairmount Park; Phila

Date sampled:

Analysis performed by: Amy Cole Ives

Date analyzed: 4-11-96

DESCRIPTION OF SAMPLE

SAMPLE No. S3(#10)

Type/Location: Rough coat plaster-Removed for scaffolding installation

Surface appearance: Light brown plaster

Cross section: No distinction or separation between layers, clear, light brown orange & dark brown sand, mica, animal hair, lime blebs

Color: 10YR 8/3 to 7/4 Very pale brown

Texture: Medium Coarse

Hardness: Very hard

Gross Wgt: 20.22 g

COMPONENTS

Fines:	Color: 2.5Y 7/6 Yellow 10YR 4/4	Wgt: 3.45g	Wgt %: 17.06%
	Organic Matter: Animal hair		
	Composition: Mica, clay		
Acid soluble fraction:	Wgt: 10.35g	Wgt %: 51.18%	
	Desc. of reaction: Vigorous Gels Evolution	Filtrate color: Yellow	
	Composition: Lime		
Aggregate: Color: Very pale brown 10YR 7/4 to light grey 2.5Y 7/2 light yellow 2.5Y 7/4 Yellow 2.5Y 7/6	Color:	Wgt: 6.90g	Wgt %: 34.12%
	Grain shape: sub-rounded, sub-angular, angular, (micas) laminar		
	Minerology: Quartz, biotite, muscovite		
	Sieve analysis: Screen	% Retained	
	8	0%	
	16	1.27%	
	30	2.56%	
	50	27.06%	
	100	48.90%	
	pan	20.21%	

ASSESSMENT

Mortar type: Lime-Sand

Fines:Acid Soluble:Aggregate: 1:3 : 2 By Weight

ARCHITECTURAL CONSERVATION LABORATORY UNIVERSITY OF PENNSYLVANIA

MORTAR ANALYSIS

Project/Site: <u>Belmont Mansion</u>																
Location: <u>West Fairmount Park, Phila</u>		Date sampled:														
Analysis performed by: <u>Amy Cole Ives</u>		Date analyzed: <u>4-11-96</u>														
DESCRIPTION OF SAMPLE		SAMPLE No. <u>S1 (#11)</u>														
Type/Location: <u>Rough coat plaster-Removed for scaffolding installation</u>																
Surface appearance: <u>Light brown plaster</u>																
Cross section: <u>No distinction or separation between layers. Clear, light brown orange & dark brown sand, mica, animal hair, lime blebs</u>																
Color: <u>10YR 8/3 to 7/4 Very Pale brown</u>		Texture: <u>Medium Coarse</u>														
Hardness: <u>Very Hard</u>		Gross Wgt: <u>23.76g</u>														
COMPONENTS																
Fines:	Color: <u>2.5Y 7/6 Yellow</u> <u>10YR 4/4</u>	Wgt: <u>3.70g</u>	Wgt %: <u>15.57%</u>													
	Organic Matter: <u>animal hair</u>															
	Composition: <u>Mica, clay</u>															
Acid soluble fraction:	Wgt: <u>11.11g</u>	Wgt %: <u>46.76%</u>														
	Desc. of reaction: <u>Vigorous gas evolution</u>	Filtrate color: <u>yellow</u>														
	Composition: <u>Lime</u>															
Aggregate:	Color:	Wgt: <u>8.95g</u>	Wgt %: <u>37.67%</u>													
	Grain shape: <u>sub-rounded, sub-angular, angular, (micaceous) laminar</u>															
	Minerology: <u>Quartz, muscovite, biotite</u>															
	Sieve analysis:															
	<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Screen</th> <th style="text-align: left;">% Retained</th> </tr> </thead> <tbody> <tr> <td>8</td> <td><u>0%</u></td> </tr> <tr> <td>16</td> <td><u>0.91%</u></td> </tr> <tr> <td>30</td> <td><u>3.10%</u></td> </tr> <tr> <td>50</td> <td><u>30.02%</u></td> </tr> <tr> <td>100</td> <td><u>47.32%</u></td> </tr> <tr> <td>pan</td> <td><u>18.56%</u></td> </tr> </tbody> </table>			Screen	% Retained	8	<u>0%</u>	16	<u>0.91%</u>	30	<u>3.10%</u>	50	<u>30.02%</u>	100	<u>47.32%</u>	pan
Screen	% Retained															
8	<u>0%</u>															
16	<u>0.91%</u>															
30	<u>3.10%</u>															
50	<u>30.02%</u>															
100	<u>47.32%</u>															
pan	<u>18.56%</u>															
Color: <u>Very pale brown</u> <u>10YR 7/4 to</u> <u>Light grey</u> <u>2.5Y 7/2</u> <u>Pale yellow</u> <u>2.5Y 7/4</u> <u>Yellow</u> <u>2.5Y 7/6</u>																
ASSESSMENT																
Mortar type: <u>Lime-Sand</u>																
Fines: Acid Soluble: Aggregate: <u>1:3:24 By Weight</u>																

ARCHITECTURAL CONSERVATION LABORATORY UNIVERSITY OF PENNSYLVANIA

MORTAR ANALYSIS

Project/Site: Belmont Mansion

Location: West Fairmount Park

Date sampled:

Analysis performed by: Amy Cole Ives

Date analyzed: 4-11-96

DESCRIPTION OF SAMPLE

SAMPLE No. S1(#12)

Type/Location: Rough coat plaster - Removed for scaffolding installation

Surface appearance: Light brown plaster

Cross section: No distinction or separation between layers. Clear, light brown orange & dark brown sand, mica, animal hair, lime blebs

Color: 10YR - 8/3 to 7/4 Very pale brown

Texture: Medium Coarse

Hardness: Very Hard

Gross Wgt: 26.84 g

COMPONENTS

Fines:

Color: 2.5Y 7/6 Yellow
10YR 4/4

Wgt: 3.66g

Wgt %: 13.63%

Organic Matter: animal hair

Composition: mica, clay

Acid soluble fraction:

Wgt: 11.64g

Wgt %: 43.37%

Desc. of reaction: Vigorous
Gas evolution

Filtrate color: Yellow

Composition: Lime

Aggregate:

Color:

Wgt: 11.54g

Wgt %: 43.0%

Color: Very pale brown

Grain shape: sub-rounded, sub-angular, angular, laminar (micas)

Minerology: Quartz, muscovite, biotite

10YR 7/4

Light grey
2.5Y 7/2

Pale Yellow

2.5Y 7/4

Yellow

2.5Y 7/6

Sieve analysis: Screen	% Retained
8	0.16%
16	1.17%
30	6.07%
50	43.93%
100	38.41%
pan	10.26%

ASSESSMENT

Mortar type: Lime - Sand

Fines: Acid Soluble: Aggregate: 1: 3.2: 3.2 By Weight

ARCHITECTURAL CONSERVATION LABORATORY UNIVERSITY OF PENNSYLVANIA

MORTAR ANALYSIS

Project/Site: Belmont Mansion

Location: West Fairmount Park, Phila

Date sampled:

Analysis performed by: Amy Cole Ives

Date analyzed: 4-17-96

DESCRIPTION OF SAMPLE

SAMPLE No. S1(#8)

Type/Location: Finish Plaster - Removed for scaffolding installation

Surface appearance: Fine chalky white

Cross section: Homogeneous white to off-white with a few minor inclusions

Color: N 9.5 White

Texture: Fine

Hardness: Hard

Gross Wgt: 0.93 g

COMPONENTS

Fines: Most of the fines appear to be contaminants from the rough coat - It was very hard to separate the two layers.

Color:

Wgt: 0.13 g

Wgt %: 14%

Organic Matter:

Composition:

Acid soluble fraction:

Wgt: 0.80 g

Wgt %: 86%

Desc. of reaction: Vigorous gas evolution

Filtrate color: Yellow

Composition: Lime

Aggregate:

Color:

Wgt:

Wgt %:

Grain shape:

Minerology:

Sieve analysis: Screen

% Retained

8

16

30

50

100

pan

ASSESSMENT

Mortar type: Lime

Fines: Acid Soluble: Aggregate:

ARCHITECTURAL CONSERVATION LABORATORY UNIVERSITY OF PENNSYLVANIA

MORTAR ANALYSIS

Project/Site: Belmont Mansion

Location: West Fairmount Park, Phila

Date sampled:

Analysis performed by: Amy Cole Ives

Date analyzed: 4-17-96

DESCRIPTION OF SAMPLE

SAMPLE No. S3(#9)

Type/Location: Finish Plaster - Removed for scaffolding installation

Surface appearance: Fine chalky white

Cross section: Homogenous white to off-white with few minor inclusions

Color: N 9.5 White

Texture: Fine

Hardness: Hard

Gross Wgt: 1.03g

COMPONENTS

Fines: Most of the fines appear to be contaminants from the rough coat - It was very hard to separate the two layers.

Color:

Wgt: 0.14g

Wgt %: 13.60%

Organic Matter:

Composition:

Acid soluble fraction:

Wgt: 0.89g

Wgt %: 86.4%

Desc. of reaction: Vigorous evolution

Filtrate color: Yellow

Composition: Lime

Aggregate:

Color:

Wgt:

Wgt %:

Grain shape:

Minerology:

Sieve analysis: Screen

% Retained

8

16

30

50

100

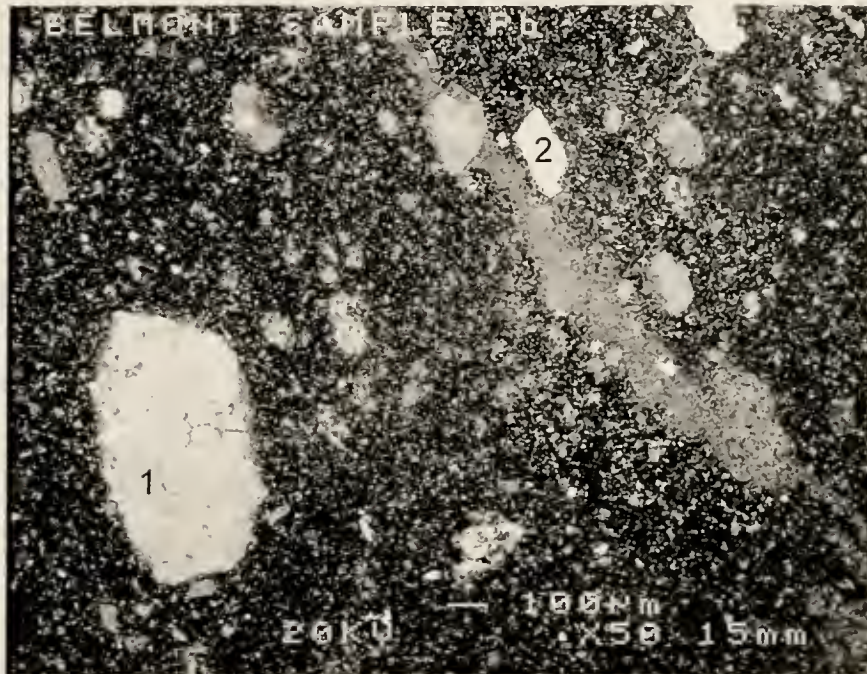
pan

ASSESSMENT

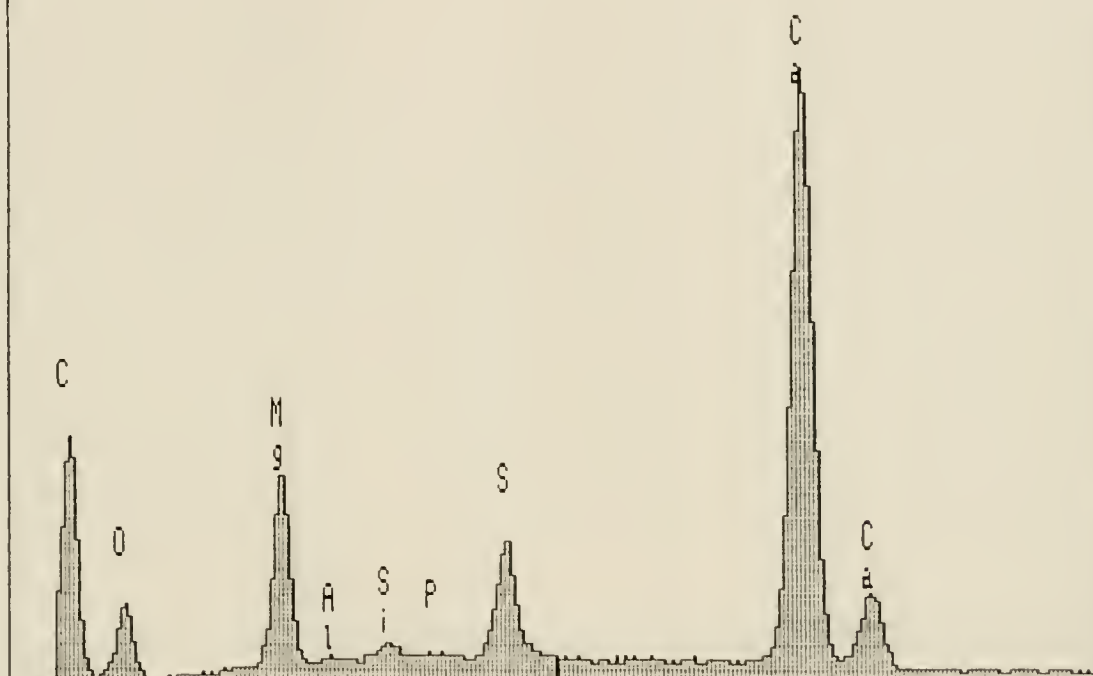
Mortar type: Lime

Fines: Acid Soluble: Aggregate:

Sample S2

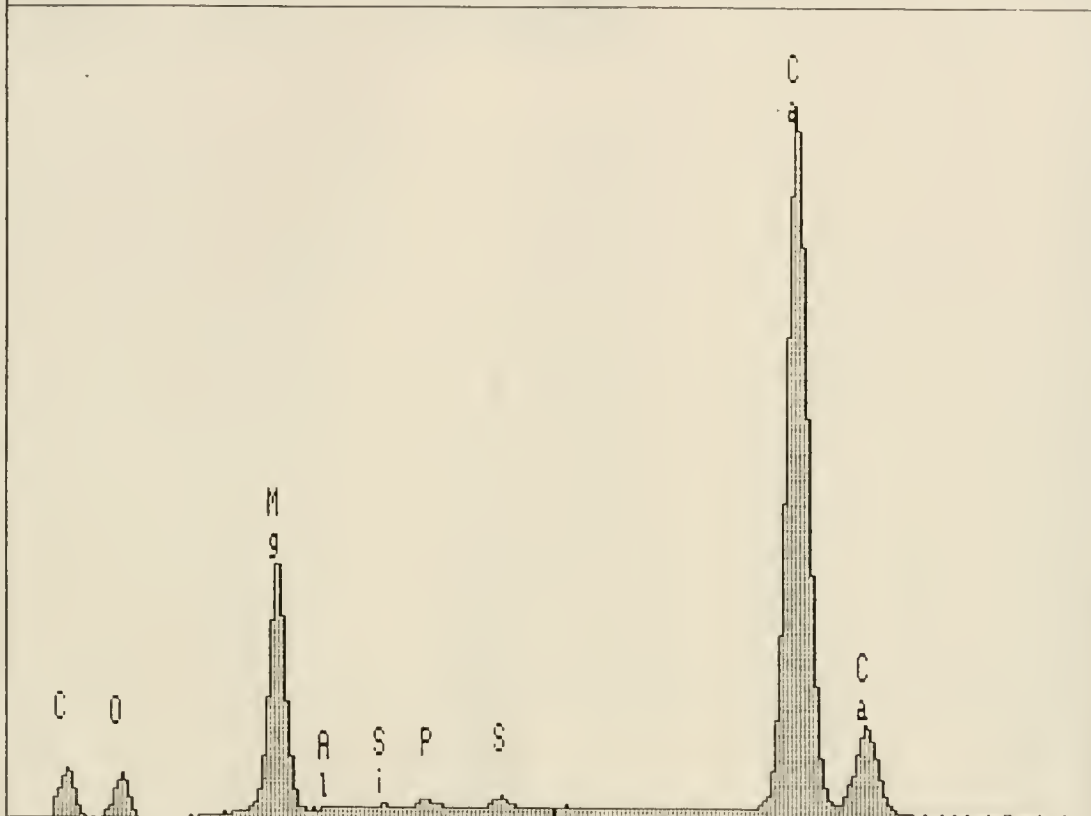


X-RAY: 0 - 20 keV Window : UTW
Live: 60s Preset: 60s Remaining: 0s
Real: 72s 17% Dead



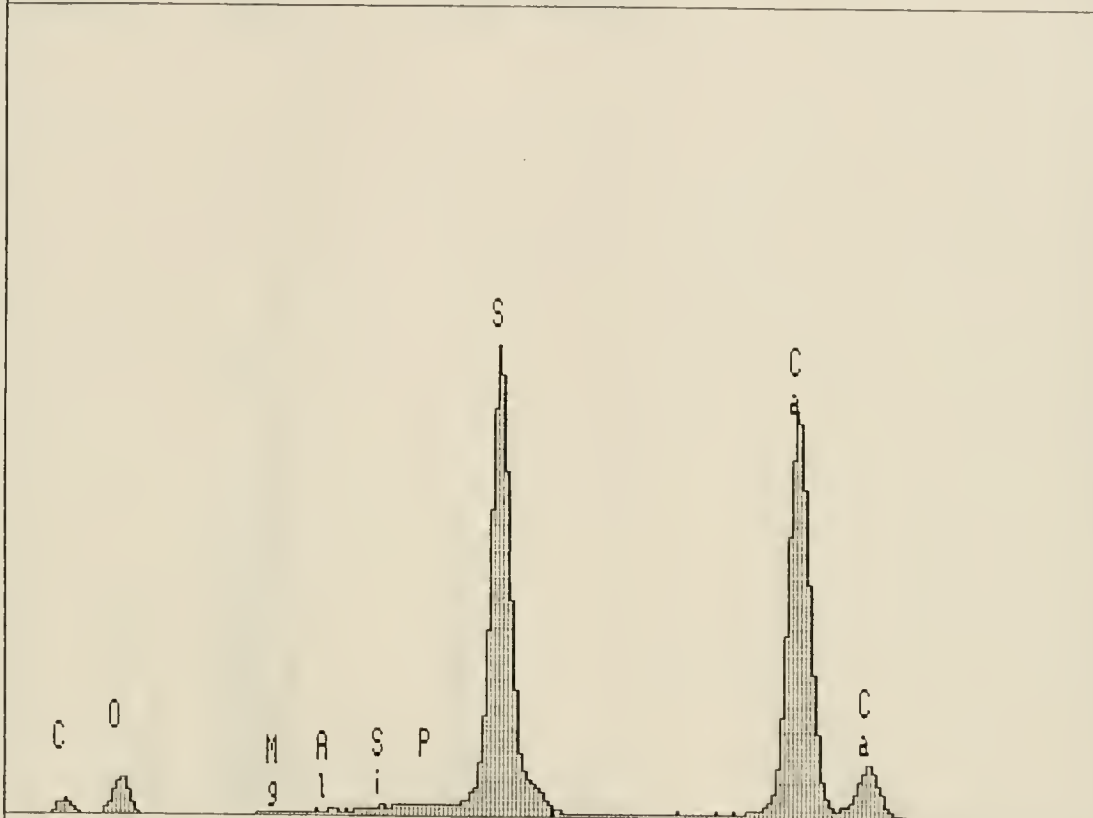
< -0.0 2.543 keV 5.1 >
FS= 8K ch 137= 266 cts
MEM1:BELMONT SAMPLE S2

X-RAY: 0 - 20 keV Window : UTW
Live: 60s Preset: 60s Remaining: 0s
Real: 78s 23% Dead



< -.0 2.543 keV 5.1 >
FS= 16K ch 137= 340 cts
MEM1: BELMONT SAMPLE S2 AREA 1

X-RAY: 0 - 20 keV Window : UTW
Live: 60s Preset: 60s Remaining: 0s
Real: 89s 33% Dead



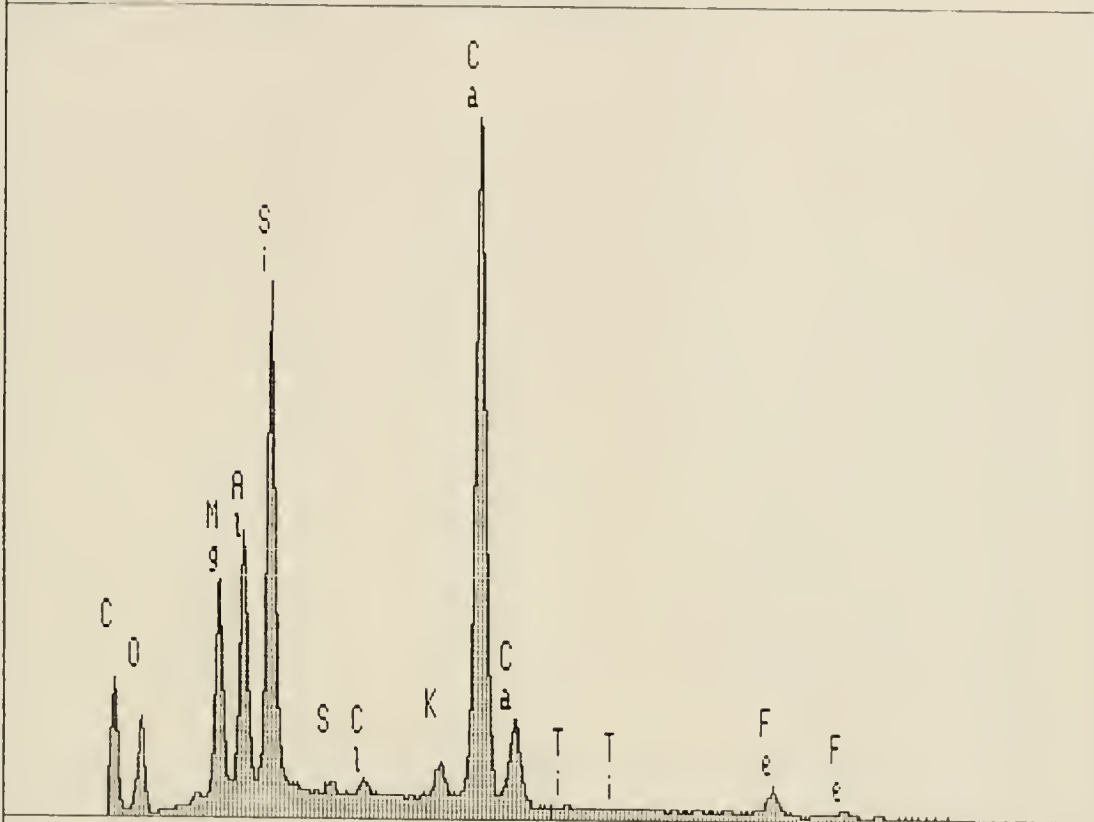
< -0.0 2.543 keV 5.1 >
FS= 32K ch 137= 583 cts
MEM1:BELMONT SAMPLE S2 AREA 2

X-RAY: 0 - 20 keV Window : UTW
 Live: 60s Preset: 60s Remaining: 0s
 Real: 78s 23% Dead



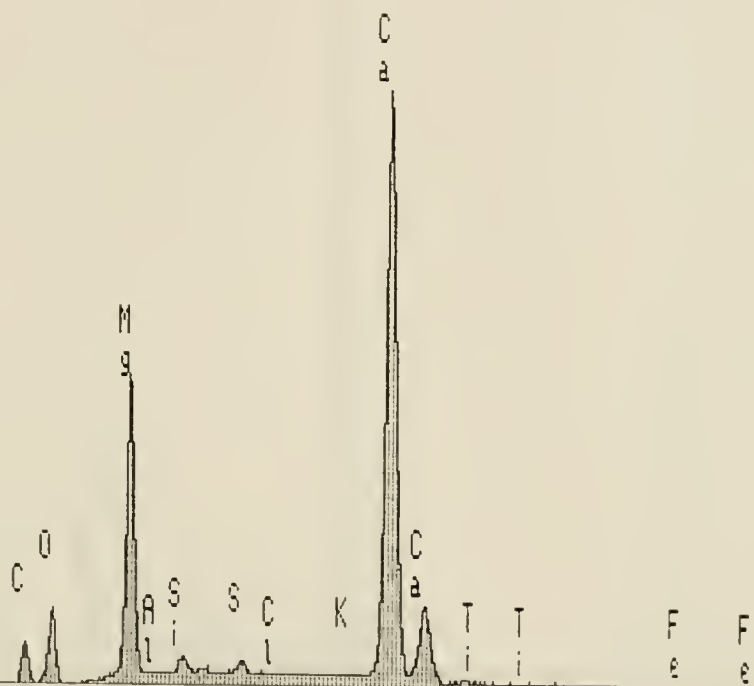
4.343 keV 9.5 >
 FS= 8K ch 227= 228 cts
 MEM1:BELMONT SAMPLE 2S1 #4

X-RAY: 0 - 20 keV Window : UTW
Live: 60s Preset: 60s Remaining: 0s
Real: 76s 21% Dead



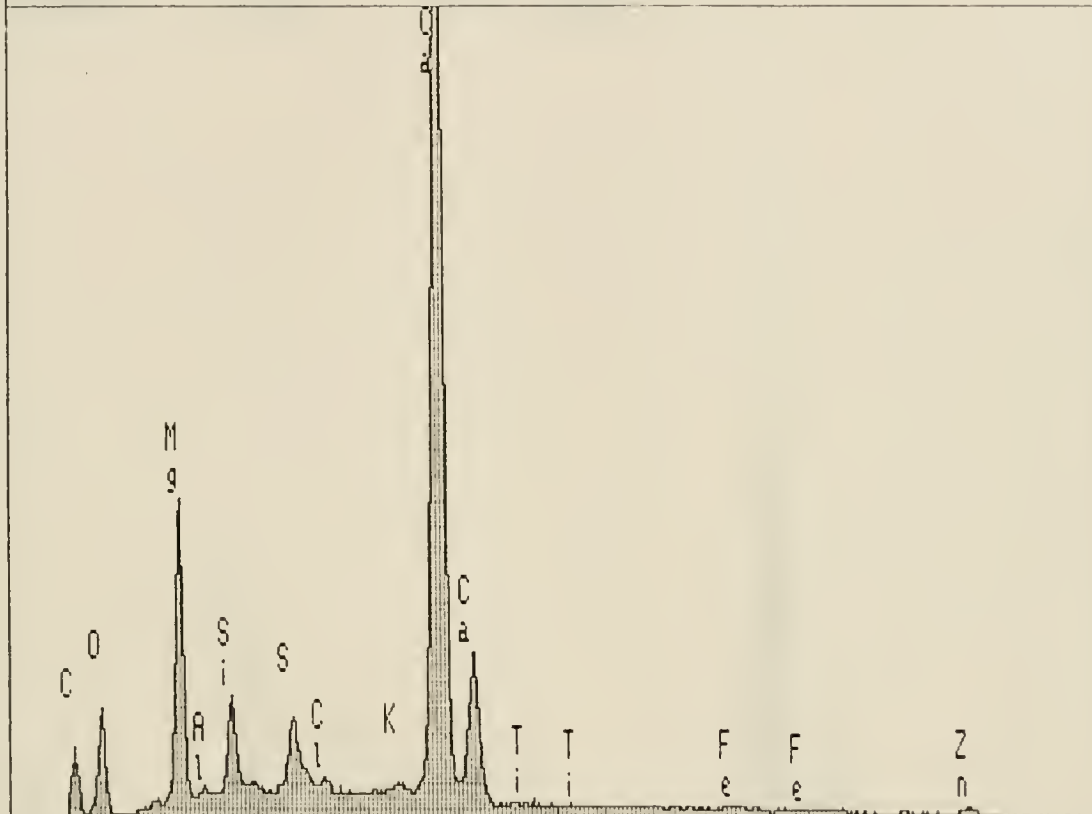
4.343 keV 9.5 >
FS= 8K ch 227= 196 cts
MEM1:BELMONT SAMPLE 2S1 #4 MATRIX

X-RAY: 0 - 20 keV Window : UTW
Live: 60s Preset: 60s Remaining: 0s
Real: 77s 22% Dead



4.343 keV 9.5 >
FS= 16K ch 227= 203 cts
MEM1: BELMONT SAMPLE 2S1 #1 FINISH

X-RAY: 0 - 20 keV Window : UTW
Live: 60s Preset: 60s Remaining: 0s
Real: 76s 21% Dead



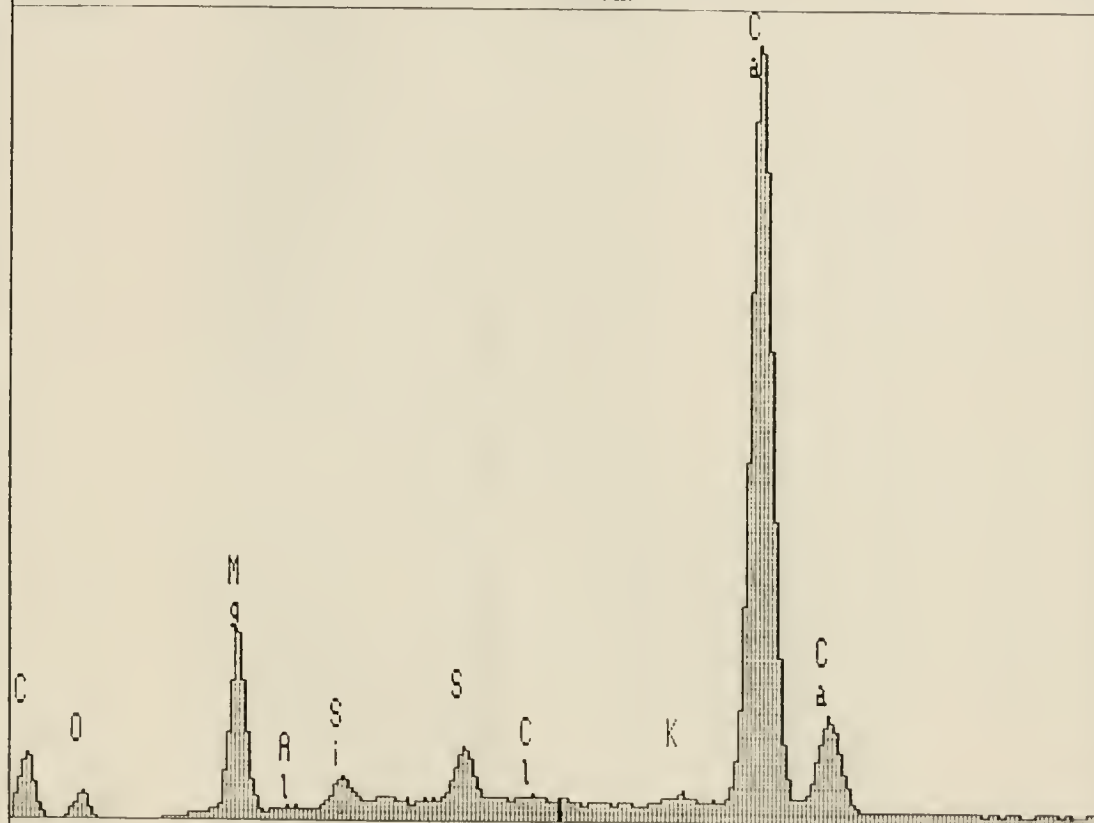
4.783 keV 9.9 >
FS= 8K ch 249= 171 cts
MEM1: BELMONT SAMPLE 2S1 #1 WW MATRIX

X-RAY: 0 - 20 keV Window : UTW
Live: 60s Preset: 60s Remaining: 0s
Real: 75s 20% Dead



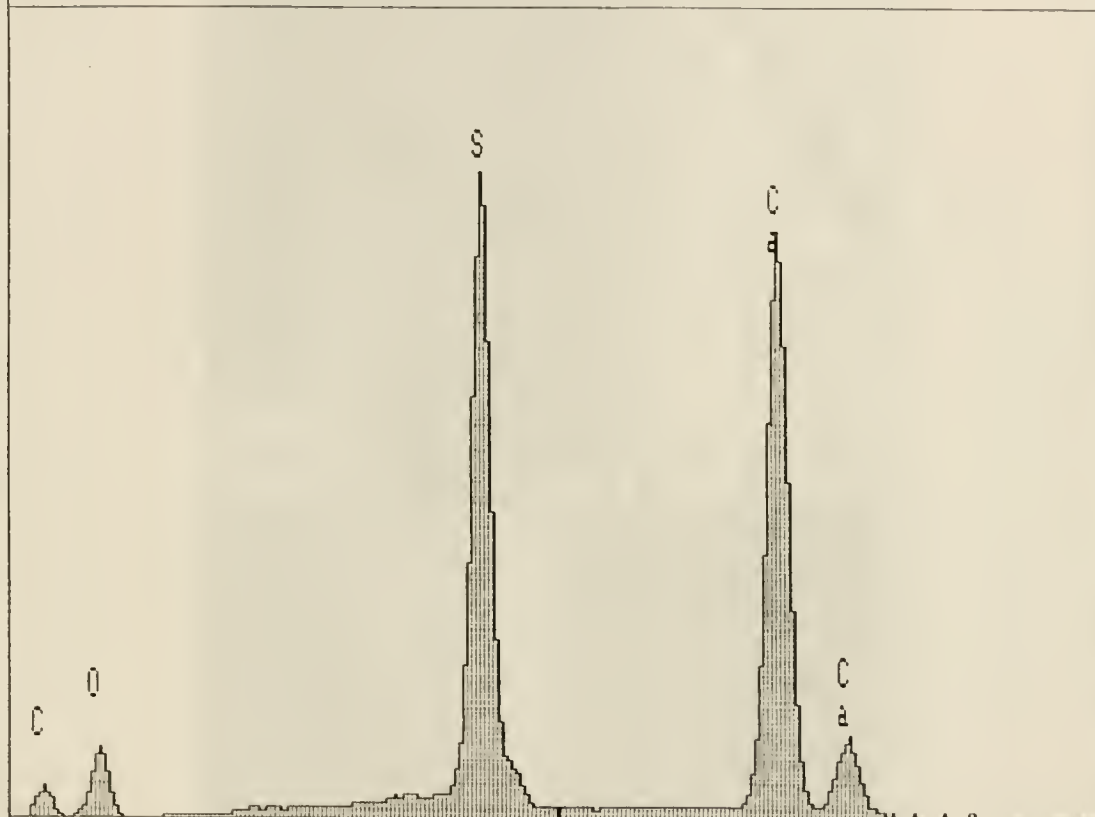
< .2 2.743 keV 5.3 >
FS= 16K ch 147= 332 cts
MEM1:BELMONT SAMPLE S4

X-RAY: 0 - 20 keV Window : UTW
Live: 60s Preset: 60s Remaining: 0s
Real: 71s 15% Dead



< .2 2.743 keV 5.3 >
FS= 8K ch 147= 265 cts
MEM1:BELMONT SAMPLE S5 (PLASTER)

X-RAY: 0 - 20 keV Window : UTW
Live: 60s Preset: 60s Remaining: 0s
Real: 81s 26% Dead

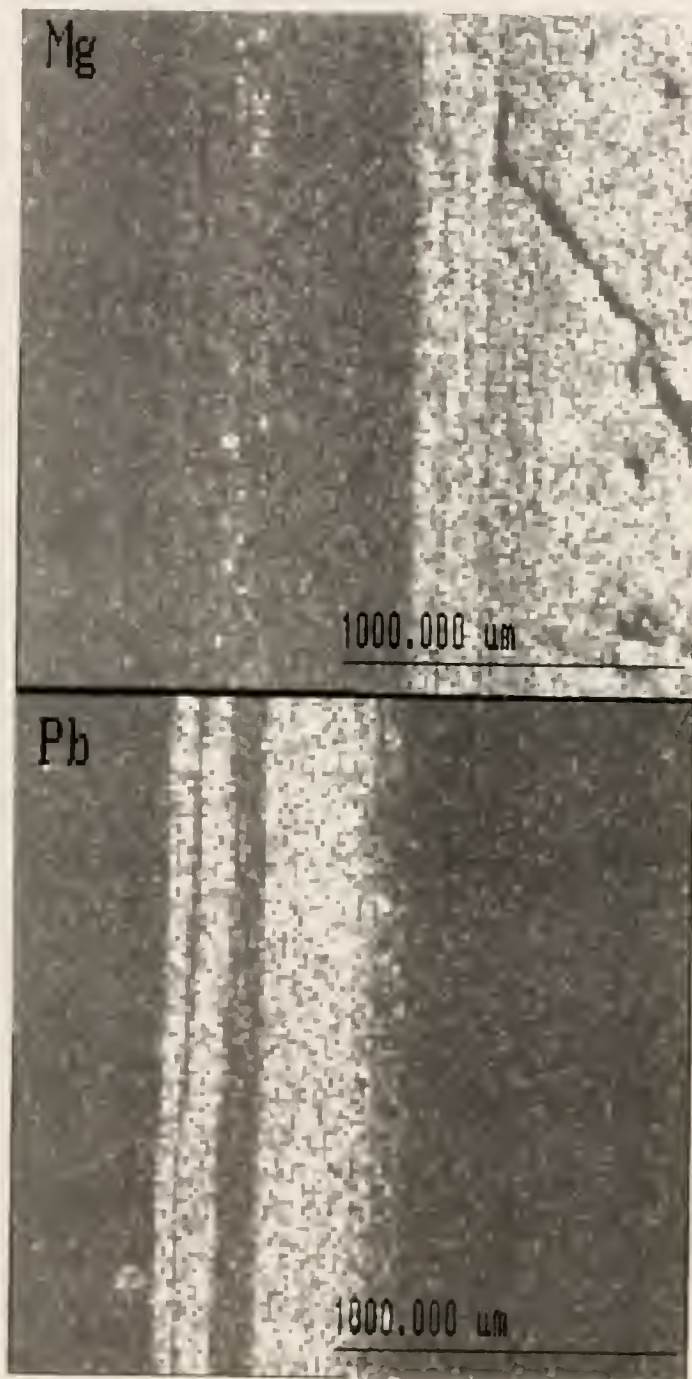


< .1 2.663 keV 5.2 >
FS= 16K ch 143= 301 cts
MEM1:BELMONT SAMPLE RM 201 KEY

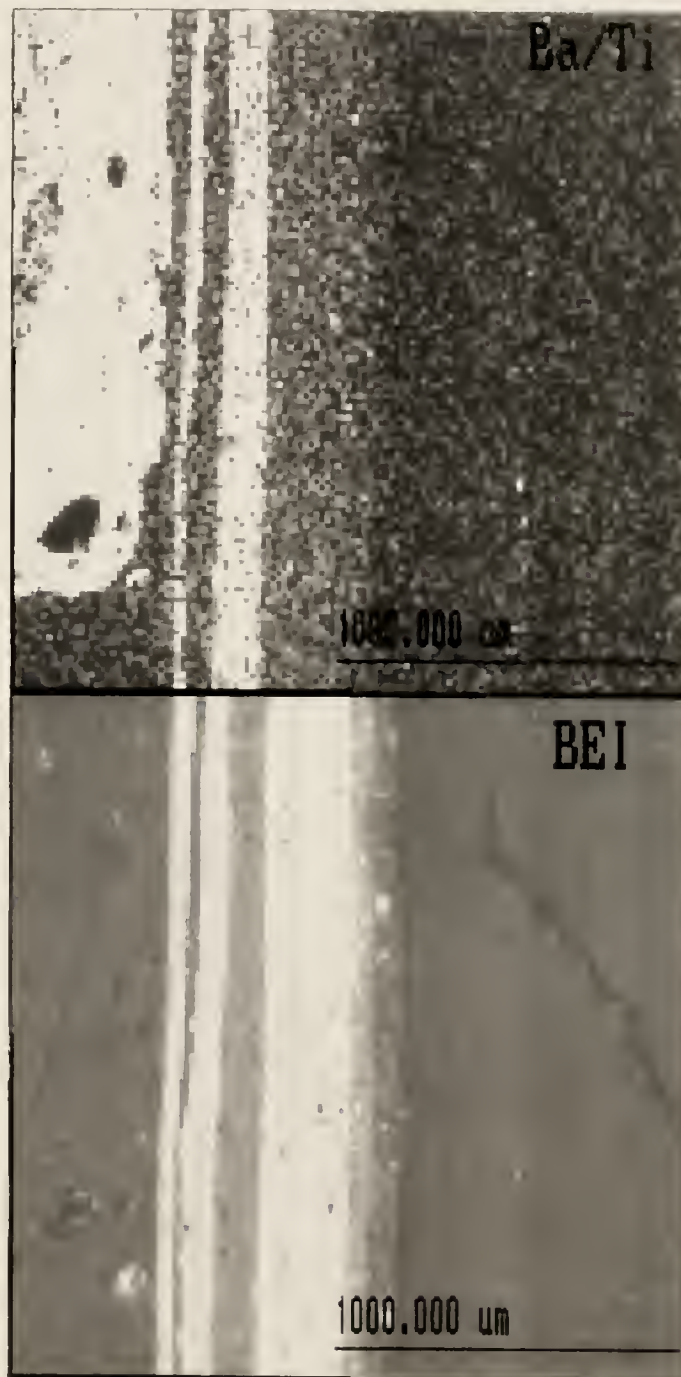
Paint Sample S3
Digital X-Ray Map



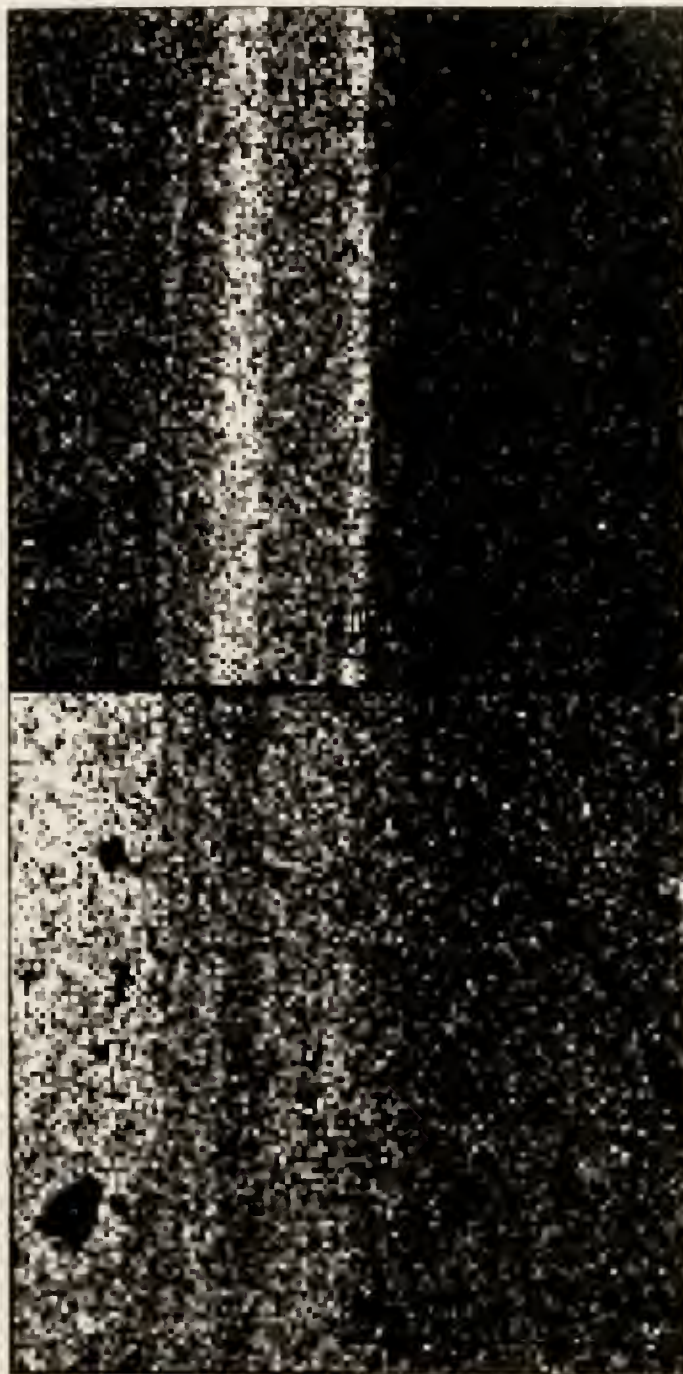
Paint Sample S3
Digital X-Ray Map



Paint Sample S3
Digital X-Ray Map



Paint Sample S3
Digital X-Ray Map

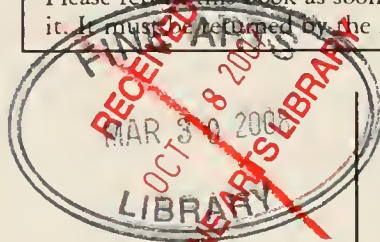


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